SAN GABRIEL RIVER BASIN
Upper Watershed Portion

SURVEY REPORT

CALIFORNIA November 1974

Prepared by
United States Department of Agriculture
River Basin Planning Staff

Soil Conservation Service Forest Service
Economic Research Service

USDA-SCS-PORTLAND, OREG. 1974

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of

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In response to the
Resolution of the Public Works Committee of
The House of Representatives, dated June 11, 1969

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This view of the San Gabriel mountains (1957) shows the Glendora valley floor (now mostly urbanized) abutting a series of short, frontal watersheds. In 1968, wildfire burned these above Glendora and Azusa. In early 1969 storms brought upwards of 60 inches precipitation in two major events during a four week period. Floods bringing mud, rock, and debris roared down from above Glendora and Azusa to cause devastation of such extent that local, State, and Federal 1/ governments declared disaster relief assistance. In contrast, the densely populated San Gabriel River flood plain, protected by three dams (one at center of photo), downstream channelization and levees, received little or no damage.

1/ The Office of Emergency Preparedness authorized the U.S. Army Corps of Engineers to render federal assistance under Public Law 875.

FOREST SERVICE PHOTO

S U M M A R Y

This is a report on a study of the San Gabriel River Drainage, which is part of the Los Angeles Basin in Southern California.

The works recommended in this report are located in the mountainous, upper watershed portion of the river basin and compliment any existing or proposed downstream works accomplished or that might be considered by the U. S. Army Corps of Engineers.

The recommended measures fall into five categories as follows:

Measure	Estimated Installation Cost in Thousands of Dollars
Fire Management	3,564
Debris Basins and Storm Drains	4,784
Land Stabilization	3,021
Sediment Management	400
Cooperative Planning	350
TOTAL	12,119

The source of funds and the land on which they are to be spent is shown below:

Source of Funds	Land Ownership Federal		Non-Federal		Total	
	(Thousands of Dollars and % of column total)					
Federal	\$5,770	95%	\$2,958	49%	\$8,728	72%
Non-Federal	\$ 330	5%	\$3,061	51%	\$3,391	28%
	\$6,100	100%	\$6,019	100%	\$12,119	100%

The annual cost of the program is estimated to be \$1,022,000 when evaluated at 5-7/8 percent interest over a 50-year period. Of this amount the cost of operating and maintaining the measures is \$372,000, 43 percent of which would be paid by the Federal government for fire management on Federal land. The rest of the annual cost, \$650,000, represents a retirement of the investment over a 50-year period at 5-7/8 percent interest.

The annual monetary benefits of the program are estimated to come from the following areas:

	Thousands of Dollars
Value of sediment reduction	
due to fire measures	652
due to land stabilization measures	121
Sub-Total	773
Damage to residential property	176
Damage to roads	127
Sediment management efficiencies	63
Total	1,139

The recommended program is estimated to have the following environmental and social effects:

1. Reduces frequency and size of large fires that burn in heavy fuels during hot, dry, and windy weather conditions.

2. Reduces the area burned to less than 1.4 percent of the upper watershed each year during a 30-year period following installation of fire management measures.

3. Reduces possibility of fire damage to life and property.

4. Reduces air pollution (smoke from wild fires).

5. Reduces sedimentation of streams and reservoirs by an estimated average amount of 640,000 cubic yards per year during effective period of measures and thus reduces sediment removal activities and the employment of excavation contractors for reservoir cleanout.

6. Prevents sediment from 0.705 square miles of watershed from flowing into urban areas by providing 161,800 cubic yards of increased catchment capacity in new debris basins.

7. Protects developed urban property from damage and loss of life from flood and debris. Will prevent damage such as that which occurred from floods of 1938 and 1969. This kind of protection is provided to at least 148 homes. Negative individual social values such as discomfort, inconvenience, insecurity, and trauma are reduced.

8. Protects existing and proposed storm drains.

9. Produces dust and noise and creates a traffic hazard on narrow residential street because of the excavating, trucking and disposing of an average of 10,000 cubic yards of sediment annually in order to maintain catchment capacity of new debris basins.

10. Reduces dust, air pollution, and road congestion associated with excavation, trucking, and dumping of debris and sediment in the mountain areas.

11. Increases sedimentation from land cleared for fuel breaks by 1000 cubic yards annually.

12. Improves vegetation on more than 77 acres of planted fill slopes and on 1750 acres of other land, and prevents about 400 probable road failures over a 20 year period and thus reduces the drain on local government revenues to maintain roads under their jurisdiction.

13. Improves visual appeal of upper watershed by reducing the occurrence and extent of land denuded by fire and by the blending of natural materials used in some structures with the surrounding geology and landscape.

14. Produces visual impact in the form of fuel breaks, helicopter landing pads, and use of non-natural raw materials in some structures.

15. Increases the amount of climax wildlife habitat during effective period of measures.

16. Benefits wildlife by planting species favoring their nutrition and cover.

17. Increases communication among local authorities.

18. Increases public safety.

19. Conserves open space.

20. Enhances outdoor recreation opportunities.

21. Provides technical data on flood hazard evaluation in support of legislative proposals to provide tax incentives for the development of green belts.

22. Establishes a common public data bank for gathering existing information on all phases of natural processes and for monitoring man's influence upon them.

I N T R O D U C T I O N

This is a report on a study of the San Gabriel River Drainage which is part of the Los Angeles Basin of Southern California.

The authority for this study was provided by the following resolution adopted by the Committee on Public Works of the House of Representatives on June 11, 1969:

> *"Resolved by the Committee on Public Works of the House of Representatives, United States, that in accordance with Public Law 639, Eighty-seventh Congress, the Secretary of the Army and the Secretary of Agriculture are authorized and directed to make a joint investigation and survey in accordance with their existing authorities of the San Gabriel River Basin, California, and to prepare a joint report on such investigation and survey setting forth their recommendations for the installation of the works of improvement needed for flood prevention or the conservation, development, utilization, and disposal of water, and for flood control and allied purposes."*

The U.S. Department of Agriculture and the U.S. Army Corps of Engineers agreed on a division of work. The Department of Agriculture agreed to focus on works of improvement needed in the upstream, mountainous portion of the San Gabriel River Basin. The Corps of Engineers agreed to focus on works of improvement needed in the downstream portion of the basin.

The Secretary of Agriculture is authorized, under Section 6 of Public Law 566, 83rd Congress, to make investigations and surveys of the watersheds of rivers and other waterways, in cooperation with other federal agencies and with state and local agencies, as a basis for development of coordinated programs.

The works recommended in this Report are complimentary to the flood control works already installed downstream by the Corps of Engineers. The Corps' task in the San Gabriel River drainage is nearly completed as attested to by the almost flawless operation of these works under the severe test imposed by the floods of January and February 1969.

NEED FOR THE STUDY

The upstream mountainous portion of the San Gabriel Basin has a history of recurrent high intensity storms and wildfires. High intensity storms occurring on inherently unstable watersheds that have been denuded by wildfire cause high volumes of runoff, sediment

THE SEQUENCE OF EVENTS THAT TYPICALLY LEADS TO A DISASTER OF THE TYPE THAT OCCURRED IN THE SAN GABRIEL DRAINAGE IN 1969:

Wildfire

FOREST SERVICE PHOTO

Denuded Slopes

FOREST SERVICE PHOTO

Flood Waters FOREST SERVICE PHOTO

Damage on the Flood Plain COUNTY OF LOS ANGELES PHOTO

and debris. The most recent fire-flood sequence occurred in 1968-1969. One person died in a mudflow and damage to public and private property in the communities of Azusa and Glendora was estimated at between $2.5 million (12) and $4 million (15).

For the past several decades various public agencies, such as the Los Angeles County Flood Control District, the U.S. Army Corps of Engineers, and the Forest Service, have installed various flood control measures in the San Gabriel Basin. These include reservoirs with flood water storage capabilities and provisions for debris retention and removal, levees and other channel structures, flood forecasting, flood water detention and debris control structures, and watershed treatment. Most of these measures have been concentrated on the main stem of the San Gabriel River and its major tributaries, and they have been generally effective in preventing losses from flooding. However, there are many relatively small canyons with flood plains of their own that are independent of the main stem and its principle tributaries. Some of these canyons do not have protective structures and the potential for damage on their flood plains is high. The floods that caused almost all of the damages in Azusa and Glendora in 1969 emanated from such canyons.

Accumulated sediment must be removed from flood control structures that are already in place in order to maintain their protective capability. The cost of sediment removal from these structures exceeds $1.7 million annually.

This study was needed to explore means to control sediment and debris and to reduce flood damages in upstream watersheds.

USDA AGENCIES PARTICIPATING IN THE STUDY

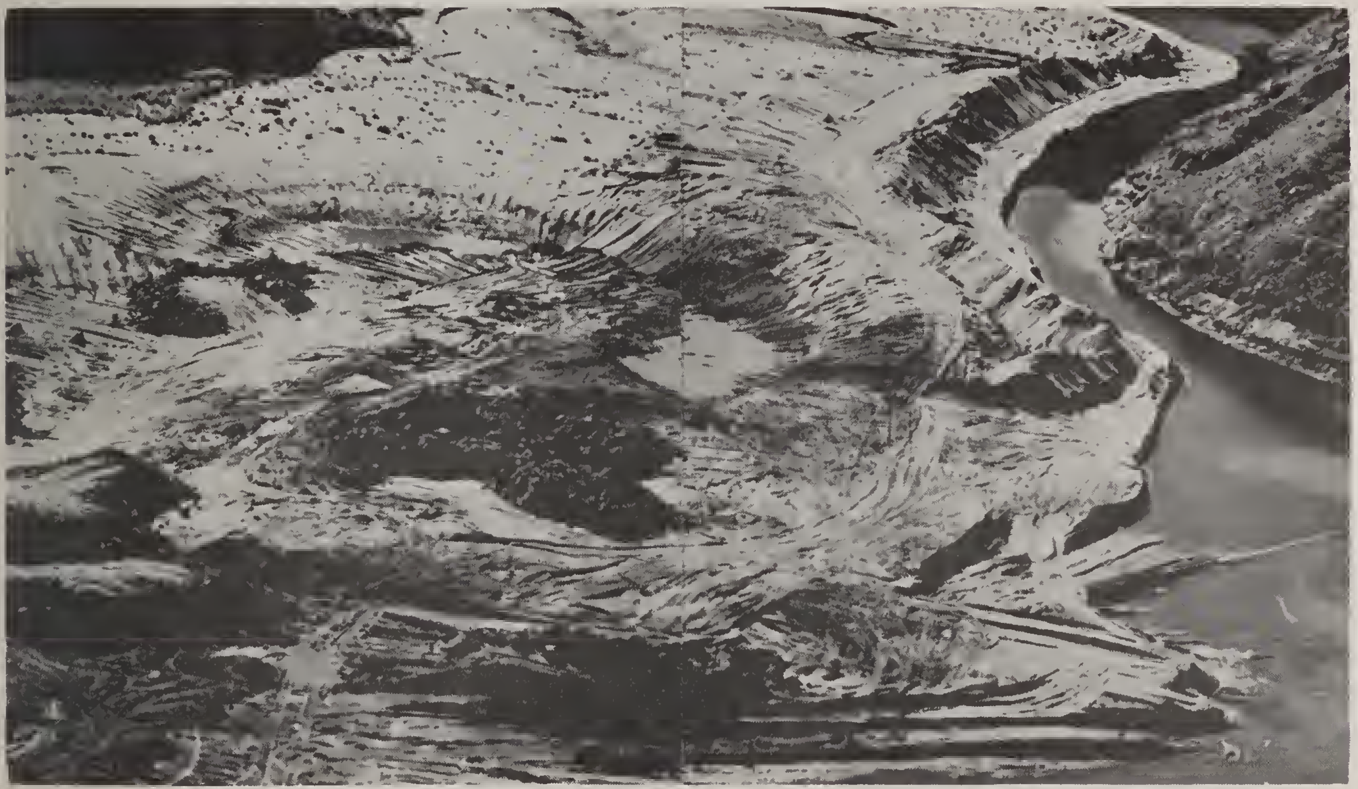
The USDA agencies participating in this study are the Soil Conservation Service, the Forest Service, and the Economic Research Service. The USDA portion of the study is controlled and directed by the California Field Advisory Committee, which is comprised of a representative of each of the three participating agencies.

USE THAT CAN BE MADE OF THE REPORT

This report provides recommendations for installation of works of improvement which can be installed under existing authorities of the USDA or cooperating agencies. Those measures that respond directly to the House Resolution have been analyzed sufficiently to assure that they are economically feasible or otherwise desirable, and

Debris was removed from the San Gabriel Reservoir under contract, for about $1.10 per cubic yard. These materials were moved upstream by conveyor belt about 3 miles to a small side canyon disposal site. About 13.5 million cubic yards were moved at a cost of almost 15 million dollars during two seasons.

USDA RIVER BASIN PLANNING STAFF PHOTO



The contracted job has been completed and the reservoir is refilling. Rocks too large for the conveyor system were left behind and appear as coarse-textured piles. An estimated 9 million cubic yards of debris still remains from the 1969 storms. Contracts for removal are presently underway. USDA RIVER BASIN PLANNING STAFF PHOTO

that the costs shown are precise enough to be used for fund allocation. A program costing $12.1 million is recommended for implementation over a ten year period. (See Tables 1 through 4, pages 60 through 63.) The recommended program would compliment any existing or proposed work being considered by the Corps of Engineers. Local funding is contingent upon approval by the Los Angeles County Board of Supervisors.

ACKNOWLEDGEMENT OF DATA, ASSISTANCE, AND COOPERATION

The Los Angeles County Flood Control District and the U.S. Army Corps of Engineers have greatly assisted by providing recommendations, reports, and data. Information was also obtained from the California State Department of Transportation, Los Angeles County Regional Planning Commission, Upper San Gabriel Valley Municipal Water District, and planning commissions of the cities of Claremont, LaVerne, San Dimas, Glendora, and Azusa. Additional information was obtained from conversations with personnel from public agencies and private concerns.

MAP I

LOCATION OF UPPER WATERSHED PORTION

SAN GABRIEL RIVER BASIN

LOS ANGELES, ORANGE AND SAN BERNARDINO COUNTIES, CALIFORNIA

AUGUST 1974

1 0 1 2 3 4 5 MILES

SCALE 1:250,000

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-22908-1

R E S O U R C E S

This chapter on resources provides a setting for discussion of problems, programs, and recommendations. The nature of the San Gabriel mountains is such that interplay between the various forces on resources can create a situation of high hazard from erosion, sedimentation, and floods. Denudation of the vegetal cover by fire on these steep, rugged, highly erodible slopes, when followed by a season of high intensity rainfall, can yield devastating floods even from small watersheds.

CLIMATIC AND METEOROLOGICAL CHARACTERISTICS

Climatic conditions in the basin vary by elevation, exposure, aspect, and distance inland from the Pacific Ocean, but are generally sub-tropical and semi-arid below 5,000 feet elevation and temperate and sub-humid above. The dry-summer, wet-winter, Mediterranean type climate predominates.

Most precipitation comes during the months of November through April from a few general, extratropical cyclonic storm systems that develop over the North Pacific Ocean and move inland on westerly to north-westerly prevailing winds (27). These systems may take three to ten days in passing, and on rare occasions leave upwards of 30 inches precipitation in some areas. Storm intensities of 6 inches or more in the upper elevations and 3 inches or more in the lower elevations per 24 hour period can be expected at a 2 year frequency interval in the mountains (9). The yearly average, however, ranges from about 13 inches along the coast to 32 inches in the upper San Gabriel mountains. Rainless periods of several months are common during the summer. About five times more precipitation can be expected in the wettest than in the dryest years of a 10 year period.

Lightning storms are infrequent, but many occur in association with both the general type storms and squalls. They usually occur over the higher and more rugged terrain. Lightning strikes, a source of some fires, are mainly confined to ridge lines in the upper elevations. Short duration, high intensity rains are particularly associated with localized squalls. Two world records for high-intensity precipitation rates were set near Mt. Wilson: 0.65 inches per minute in 1926; and 26.13 inches per 24 hours in 1943 (17).

Snowfall can be expected from December to March at elevations above 4,000 feet. Accumulations of snow pack are sufficient in the upper areas on a few of the northerly facing slopes for limited recreational skiing. Snowfall rarely occurs below elevations of 1,000 feet.

Winds are usually of insufficient velocity to remove buildups of smaze and smog from the South Coast Air Basin. A persistent inversion layer often causes air pollutants to accumulate within the first 5,000 feet of elevation. During the day onshore breezes normally push this smog-laden air into the mountains and across the lower passes.

Gentle daytime onshore breezes push inland from the coast, producing weak up-slope and up-canyon winds in the San Gabriel Mountains. With night-time cooling, they reverse in direction to produce down-canyon and off-shore winds, usually of lesser magnitude than the day-time breezes. During the period from November to April, strong Santa Ana winds (Foehn) wipe out these patterns. They flow over the ridges and down along the surface of leeward slopes and valleys and on to the sea. It is these winds, coupled with warm temperatures and humidities lower than 5%, that set the stage for serious fire conditions (20). They originate from high pressure systems in the Great Basin vicinity, and flow seaward into a somewhat static low-pressure offshore trough. Humidities, though relatively high along the ocean front, diminish rapidly with distance inland.

The chance of frost in winter increases with elevation and with distance inland. In 30 years of record Los Angeles has received frost only four times, whereas Riverside lists 104 times and San Bernardino 120 times (29). The mean annual temperature at Los Angeles is 61¼ F.

The growing seasons for crops are nearly year-round. Citrus fruits and the more frost susceptible crops are grown on the alluvial fans and steeper foothills that have good air circulation. Flatter portions of the valley floor are subject to more frequent and severe freezes (23).

GEOMORPHIC, PHYSIOGRAPHIC AND GEOLOGIC FEATURES

Two striking geomorphic features of the drainage system are the San Gabriel Mountains and the San Gabriel Valley.

The San Gabriel Valley, a part of the Los Angeles basin, is an area of deposition that includes loose to well indurated Cenozoic continental and marine sedimentary rocks up to 2,000 feet thick. The Puente Hills and the San Jose Hills, comprised of folded and faulted tertiary sedimentary rocks, are within the bounds of this narrowly elongated valley.

Shown above is mature topographic development typical to the area as seen in the west fork of the San Gabriel River, and looking eastward toward snow capped San Antonio Peak (Mt. Baldy). The preponderance of lateral channels within main laterals indicates a series of rejuvenated erosional cycles. The area currently seems to be in a geologic period of accelerated erosion.

USDA RIVER BASIN PLANNING STAFF PHOTO

At left, the natural slump is a result of hydrologic failure in super-saturated soils during the 1969 storms. Its location is near Crystal Lake area along State Highway 39.

USDA RIVER BASIN PLANNING STAFF PHOTO

The San Gabriel Mountains, part of the east-west trending Transverse Range Geomorphic Province, rise in elevation from 500 feet in the frontal zone to 10,080 feet at Mount San Antonio. The crystalline core of the San Gabriels is composed of severely folded metamorphic rocks, such as gneiss and schist, that were intruded during Jurassic and Cretaceous time by plutonic granitic rocks. Minor amounts of Miocene age volcanic rocks crop out along the frontal zone.

Tremendous compressive forces due to movement on the active San Andreas-San Jacinto fault systems have caused north-south crustal shortening to form the uplifted San Gabriel Mountains, the downwarped San Gabriel Valley and associated shearing, fracturing, folding and thrust faulting.

The range is characterized by deep, incised, V-shaped canyons, steep side slopes, and sharp crested ridgelines. The drainage patterns strongly reflect the fault network. For example, the East and West Forks of the San Gabriel River follow the trace of the San Gabriel fault. The weathering of the crystalline bedrock is highly variable ranging from slight in the hard, massive rock to intensive in highly fractured or faulted rock. The oversteeped side slopes that result from channel downcutting are quickly eroded by agents of water and gravity. Landslides, debris slides and soil slips, examples of mass movement, are particularly effective in degrading the landscape. Tremendous quantities of soil and rock materials are delivered into and carried away by the mountain streams and deposited in the valley below as coalescing alluvial fans. Some of man's activities, such as road building, type conversion, and fire, can greatly accelerate the already high natural geologic rate of erosion.

SOILS

Soil surveys recently have been completed for the entire area. The Soil Conservation Service's report, "San Gabriel River Basin Soil Survey," 1972 (26) covers the watershed from the Angeles National Forest Boundary to the shores of the Pacific Ocean. The Forest Service has completed a survey of the area within the National Forest Boundary and the report will be issued in 1974. Results of the two surveys are described separately because slightly different techniques were used, although the information derived is compatible.

SOILS OUTSIDE THE NATIONAL FOREST

Thirty soil associations (identified by the major soil series in each) and six miscellaneous lands have been identified in the survey. The associations range from deep soils on nearly level slopes to very

shallow soils on extremely steep slopes. Broad interpretations for hydrologic soil groups, erosion hazard, land capability, shrink-swell potential, septic tank filter fields, soil nutrient deficiencies, and moisture storage capacity can be made for each soil series in each association on the basis of the characteristics and properties of the soil series.

Alluvial soils occupy about 53 percent of the area. Textures range from sand to clay, and slopes are nearly always less than nine percent. A large, nearly level area near the ocean was poorly drained under natural conditions. Deep pumping and deepened drainages have lowered the water table, so these soils presently are suitable for urban development, except in a few small, scattered locations. The largest area of alluvial soils consists of fans and flood plains from the San Gabriel River and other drainages originating in the San Gabriel Mountains. They occur in the north and west portion of the survey area. Soils close to these drainages are stony and gravelly sands or loamy sands. Away from the drainages but in the same flood plains, the soils have loamy sand or sandy loam profiles.

About 13 percent of the survey area consists of terrace soils, which occur at higher elevations than the alluvial soils. The largest areas of these soils occur between the Puente and Los Coyotes Hills between the San Gabriel Mountains and San Jose Hills. The terrace soils typically have loam surfaces and clay loam or clay subsoils. They are formed in old, deep alluvial deposits and are erodible when disturbed. Most areas are on slopes less than 9 percent although some have slopes up to 30 percent. They are easy to shape and develop for urban use.

Upland soils occupy about 27 percent of the area outside the National Forest. In the San Gabriel Mountains, these soils are formed on granitic bedrock on steep to extremely steep slopes. They are less than 20 inches deep to bedrock and are medium textured.

The other upland soils occur on the San Jose, Puente, and Los Coyotes Hills. These hills consist mainly of shale, sandstone, and soft conglomerate formations. Soils formed on the shale bedrock tend to be fine textured on smooth rolling topography. The soils formed on the sandstone formations are sandy loam textured; slopes are usually steep and topography sharp and angular. Soils formed on the soft conglomerates usually are cobbly or gravelly loams with slopes ranging from around 15 percent to over 75 percent. In some steeper portions, extensive badland areas have developed with barren exposures and slopes over 100 percent. All of the upland soils except those formed

on granitic bedrock are easily developed for housing or other use because the underlying bedrock is easily cut. Firm bedrock makes the granitic areas difficult to reshape.

About 6 percent of the area is classified as "Miscellaneous Land." With the exception of Riverwash, most of it has been altered by man and machines so that the original surface soils can no longer be classified. Land forms have been changed to develop special uses such as housing tracts and sanitary land fills.

SOILS WITHIN THE NATIONAL FOREST

Soils were field mapped directly into interpretive groups without identifying and delineating soils series or soil associations. This mapping system utilizes a "closed" legend that consists of four hydrologic groups, three soil depth classes, parent rock identification, three slope classes, vegetal types, and three vegetal crown cover density classes. Generally, representative soil profile descriptions have been taken. These are classified into the U.S. Department of Agriculture's Soil Taxonomic System (25). According to this system most of the area consists of Typic Xerorthents and Typic Xerochrepts, moderately coarse to coarse textured, shallow to skeletal, and underlain by strongly fractured bedrock.

Soils on steep, north-facing slopes are moderateley coarse-textured with dark-colored surface horizons, underlain by strongly fractured bedrock, and in many places alternated with bands of stony colluvium. In some sloping high terraces on the North Fork of San Gabriel River and San Antonio Creek, where these soils occur in separate bodies sufficiently large to delineate, they are classified as Typic and Entic Haploxerolls.

On ridge crests at elevations of about 3,000 to 6,000 feet, a few bodies of more strongly developed soils occur on lesser slopes. These appear to be remnants of older land surfaces. They have reddish brown, moderately fine-textured subsoils with moderate to strong angular blocky structure. They have tentatively been classified as Typic Haploxerults. These soils are of particular interest, since they suggest soil development in an era that may have received somewhat greater precipitation, or was tectonically more stable.

On very steep slopes along the front of the San Gabriel Mountains, and at elevations above 6,000 feet, extensive areas of exposed bedrock occur, mostly in associations with shallow, coarse-textured soils. It is estimated that such areas of exposed bedrock constitute about 30 to 40 percent of the delineations in which they occur.

Areas of riverwash, and soils on low terraces along major streams are dark-colored, very gravelly, and coarse-textured. They are classified as Entic Haploxerolls.

Recent rock slides at high elevations in the watershed consist of barren, fractured rock, with extensive talus slopes of angular rock fragments at their bases. The latter are in some places stabilized by brush vegetation, and may develop stoney, coarse-textured soils.

Soil depth has been estimated on the basis of the amount of soil material available to plant roots, and as to how it is affected by biolobic and pedogenic processes. Nearly all upland soils in the watershed are less than 40 inches in depth, and most are less than 20 inches. However, most soils are developed in highly fractured, decomposing rocks, which permit roots and water to penetrate well beyond those depths.

VEGETATION

Four main vegetal types occur within the study area. They are chaparral, mixed conifer, hardwoods (woodland) and in the lower, open country, grasslands.

The chaparral vegetal type covers well more than half of the mountainous portion of the watershed, and also extends into the mixed conifer and woodland vegetal types as undergrowth. Chaparral consists of xerophytic shrubs and scrub trees that are well adapted to withstand long periods of rainless, hot weather. These plants grow mostly in winter, and early spring, when soil moisture levels are high.

A few of the chaparral plant species include: chamise *(Adenostema fasciculatum)*, manzanita *(Arctostaphylos spp.)*, laurel sumac *(Rhus laurina)*, sagebrush *(Artemisia californica)*, California buckwheat *(Eriogonum fasciculatum)*, California lilac *(Ceanothus spp.)*, toyon *(Heteromeles arbutifolia)*, scrub oak *(Quercus dumosa)*, black sage *(Salvia mellifera)*, and yucca *(Yucca whipplei)*. Big sagebrush *(Artemesia tridentata)* grows near the crest of the San Gabriel Watershed, where some summer rainfall occurs. Scrub oak *(Quercus dumosa)* is a dominant species on north facing slopes.

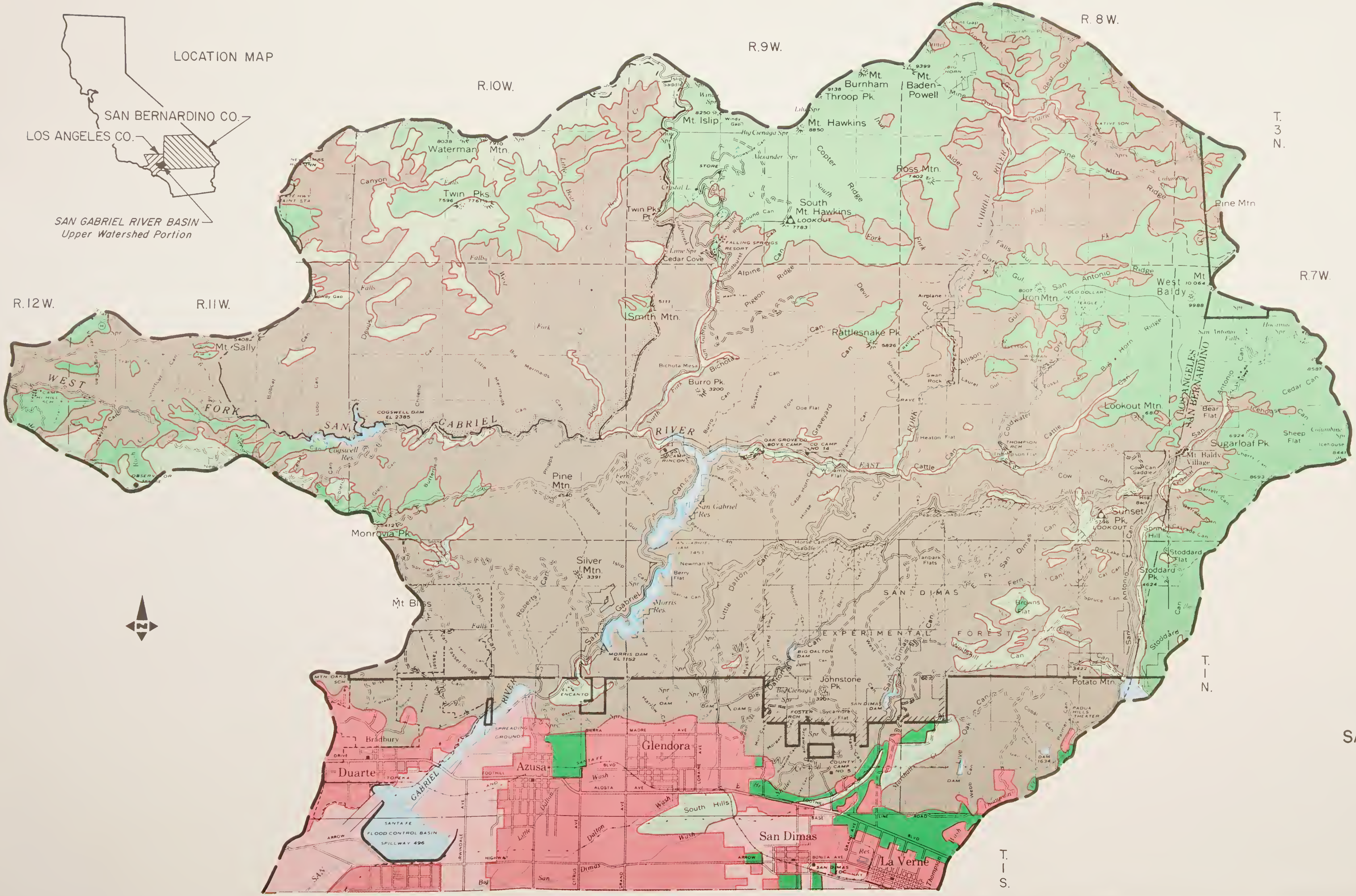
About one-third of the San Gabriel Mountains is occupied by conifers. These occur in open, lightly stocked, mixed stands. Species commonly represented are sugar pine *(Pinus lambertiana)*, ponderosa pine *(P. ponderosa)*, Jeffery pine *(P. jeffreyi)*, incense cedar *(Libocedrus decurrens)*, and white fir *(Abies concolor)*. Limited amount of limber pine *(P. flexilis)* and lodgepole pine *(P. murrayana)* occur in pure stands. Relict islands of big cone spruce *(Pseudotsuga macrocarpa)* can be found in canyon bottoms and on north facing slopes from the valley floor to 8,000 feet elevation. It is frequently associated with canyon oak *(Q. chrysolepis)*, also called goldcup oak.

Chaparral commonly attains heights of 8 to 14 feet in the watershed. Manzanita and live oak are the principal species above.

FOREST SERVICE PHOTO

This overview of the upper east fork of San Gabriel River shows a stand of conifers typical to the area. Mt. Baden Powell (9,399 feet elevation) is at upper left.

FOREST SERVICE PHOTO



LEGEND

- Mixed Conifer
- Woodland
- Chaparral
- Grassland
- Orchards
- Urban
- Water

MAP 2

VEGETAL COVER TYPES

SAN GABRIEL RIVER BASIN

UPPER WATERSHED PORTION

CALIFORNIA

OCTOBER 1974

1 0 1 2 3 MILES

SCALE 1:126,720

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1974

M7-N-23347-1

The woodland type blends into conifer in the upper elevations, where canyon oak is most common. Canyon oak and interior live oak *(Q. wislizenii)* occur in the middle elevations. In the canyon bottoms the woodland type consists of coast live oak *(Q. agrifolia)*, sycamore *(Platanus rasemosa)*, California-bay *(Umbellularia californica)*, big leaf maple *(Acer macrophyllum)* and white alder *(Alnus rhombifolia)*.

Grasslands are comprised of grasses and forb species that include wild oats *(Avena fatua)*, soft chess *(Bromus mollis)*, ryegrass *(Lolium spp.)*, filaree *(Erodium spp.)*, needlegrass *(Stipa spp.)*, deergrass *(Muhlenbergia rigens)*, mustard *(Brassica campestris)*, ripgut brome *(Bromus rigidus)*, pine bluegrass *(Poa scabrella)*, buckwheat *(Eriogonum spp.)*, sage *(Savia spp.)*, lupine *(Lupinus spp.)*, and nitgrass *(Gastridium ventricosum)* (24).

Fire plays a dynamic role in vegetal cover stand densities, and in species composition of the plant communities. Areas with soils of sufficient depth to support forest and woodland vegetal types may be converted to chaparral temporarily, and repeated fires may eliminate a viable seed source to regenerate the hardwood and conifer species. In the chaparral type, frequent fires may be responsible for a gradual increase in chamise, since deer prefer browsing the tender, more succulent new sprouts of other plant species to chamise, Subsequent erosion truncates soil horizons and produces a more undulating and xeric soil.

Canopy density in unburned areas often reaches 100%, and becomes tall and entangled. Following a fire, rapid regrowth usually continues for about 10 years, after which time the entanglement of live branches and dead wood begins restricting passage to man.

HYDROLOGIC RELATIONS

Streamflows in the basin fluctuate greatly. They vary from high-volume, rapidly-peaking flows of relatively short duration to very minimal flows or, in many cases, no flows at all. During high-runoff periods, streams are often heavily laden with mineral soil, rock, and organic debris. These types of flows are a part of the natural phenomenon in the area. They are directly related to the highly variable amounts and character of precipitation described under the preceding "Climatic and Meteorological Characteristics" section, and indirectly to the denudation of vegetation from mountain side slopes, mainly by fire.

The volume of overland flow increases with decreases in soil depth and density of vegetal ground cover. Surface runoff is high in areas of exposed bedrock, very shallow soils, and from areas where vegetation has been removed by fire or other means. Since the greatest amounts of precipitation are normally expected in the upper elevations, highest potential for run-off exists there. Events (man caused or other) that decrease the depth of soil, or decrease the vegetal canopy, result in larger and more frequent flash floods, with a subsequent increase in erosion and sedimentation.

During winter, warm, moisture laden storm systems occasionally produce rain on snowpack. When these persist for sufficient duration, run-off in excess of precipitation results.

Water for ground-water recharge to the San Gabriel Basin from precipitation in the San Gabriel Mountains is a valuable resource. Much recharge water originates in the upper elevations where precipitation is greatest. Areas that provide the most water for recharge are (1) talus slopes, (2) coarse textured soils, (3) shallow permeable soils that retain only small amounts in the profile, and (4) channel alluviums.

The coarse textured alluvium present in most channel bottoms provides the main route for substrata flow from the San Gabriel Mountains. It also serves as a filtering field where surface water from overland channel flows can percolate. Special percolation fields have been developed in the valley to recharge ground water depleted by wells within the Los Angeles ground water basin. The Santa Fe Dam is an example of such a percolation facility.

Between 1950 and 1965 ground water levels declined because ground water withdrawals exceeded inflows. However, by mid-1969 ground water levels had risen to elevations comparable to those of 1947 apparently as a result of importation of water for ground water replenishment and above average rainfall between 1965 and 1969.

The U. S. Geological Survey recognizes three ground-water sub-basins within the San Gabriel river basin (28). Ground-water recharge by injection wells places imported Colorado River water into the underground reservoir to maintain a barrier against salt water intrusion near the ocean frontal zone.

LEGEND

- Fisheries Areas
- Areas Key to Deer Management
- Bear Habitat
- Bighorn Sheep Habitat

MAP 3

WILDLIFE MANAGEMENT AREAS

SAN GABRIEL RIVER BASIN

UPPER WATERSHED PORTION

CALIFORNIA

OCTOBER 1974

1 0 1 2 3 MILES

SCALE 1:126,720

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M7-N-23347-2

WILDLIFE

A wide variety of wildlife can be found within the area. These include amphibians, reptiles, fish, birds, and mammals. Representative species within these groups are listed below.

Group	Representative Species
Amphibians	frogs, tree frogs, California newt, Salamanders, toad and spadefoot.
Reptiles	lizards, whiptail, skink, and snakes.
Fish	trout, chub, sucker, sunfish, dace and bullhead.
Birds	waterfowl, vultures, kite, hawks, eagles, owls, dove, pigeons, quail, swifts, swallows, hummingbirds, woodpeckers, jays, goatsuckers, warblers, blackbirds, gnat catchers, kinglets, shrikes, vireos, thrushes, solitaires, bluebirds, nuthatches, wrens, threshers, flycatchers, kina birds, larks, orioles, tanagers, grosbeaks, finches, sparrows, and buntings.
Mammals	opossum, shrews, moles, bats, weasels, skunks, raccoon, ringtail, coyote, foxes, mountain lion, bobcat, rabbits, tree squirrels, ground squirrels, rats, mice, deer, big horn sheep, black bear.

Species that have become extinct from the area within the last few decades include the grizzly bear and the unarmored three-spine stickleback. Rare and endangered species presently include eagles and the western burrowing owl. Special laws protect others from hunting or molestation that could lead to extinction.

The present population of big game within the San Gabriel Mountain area is estimated at:

Black bear	10
Desert bighorn sheep	300
California Mule Deer	3,000

Game populations are regulated by state laws that control the season, size of animal, age, sex, and numbers of animals killed. Desert bighorn sheep are completely protected by state law at present.

About 1,350 acres of lake surface lies within the National Forest portion of the watershed. Of this, 900 acres is open to public fishing. Several small streams are also available for fishing.

Map 3 shows key habitat for deer, bighorn sheep, and black bear. Most of the fisheries are maintained by put-and-take stocking.

ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Development of Southern California 1/ has followed the classical model of economic growth. The economy was initially dependent upon the resource industries of agriculture, fisheries, and mineral extraction. Infra-structure development and a favorable climate led to growth of manufacturing industries, which in turn stimulated growth of the trade and service sectors.

Southern California was bypassed by the population influx to Northern California that was stimulated by the 1849 gold rush and completion of the first transcontinental railroad. In 1870, Southern California's population was 38,000, less than seven percent of the state's total. Following railroad linkage to San Francisco in 1876, the population grew rapidly. By 1890, Southern California's population had reached 221,000, about 18% of California's total.

Amenable climate and job opportunities provided a continual stimulus to population growth. Population grew at a rate six times the national average in the decades between 1900 and 1920. By 1930, Southern California's population exceeded fifty percent of the state's total population.

During World War II, high wages paid by shipyards, aircraft plants, and other defense related industries provided additional stimulus to population growth. Between 1940 and 1950 Southern California's population increased by two million. Defense related employment opportunities remained high due to the Korean conflict and development of the aerospace complex in the late 1950's. Aerospace and defense related employment accounted for over eleven percent of total civilian employment and over forty percent of manufacturing employment in 1967 (11). Historical population levels are shown in the following tabulation.

It is the population growth, with attendant industrial and service sector development, that is at the root of flood and sediment damage problems. Fast growth has led to development of the flood-plains with often inadequate protection or protection that is afforded only after considerable damage has occurred.

1/ Southern California includes the counties of Los Angeles, Orange, San Diego, San Bernardino, Riverside, Ventura, Santa Barbara, San Luis Obispo, Imperial, and Inyo.

Population

Year	California	Southern California	Los Angeles County
1850	165,000	5,849	3,530
1860	379,994	26,533	11,333
1870	560,247	38,760	15,309
1880	864,694	76,441	33,381
1890	1,213,398	220,968	101,454
1900	1,485,053	325,225	170,298
1910	2,377,519	777,667	504,131
1920	3,426,859	1,375,974	936,455
1930	5,674,251	2,968,963	2,208,492
1940	6,907,387	3,713,234	2,785,643
1950	10,586,223	5,715,324	4,151,687
1960	15,717,204	9,118,422	6,038,771
1970	19,779,156	11,704,713	6,993,371

Source: Tabulations of U. S. Census of Population Data by the California Department of Finance

NON-AGRICULTURAL INDUSTRIES

The manufacturing, trade, and service industries are the largest employers in Los Angeles County. In 1969, these three industries provided more than 60 percent of total employment and more than 70 percent of total wage and salary employment. Los Angeles County is the third largest manufacturing center in the Nation. Non-agricultural wage and salary employment by industry is shown below.

Industry	Yearly Employment in Thousands 1950	1960	1969
Mineral Extraction	12.8	10.4	11.9
Construction	102.7	111.9	105.4
Manufacturing	414.5	738.7	878.7
Transportation & Utilities	108.5	136.7	177.1
Trade	343.5	475.4	627.6
Finance, Insurance, Real Estate	66.4	114.5	160.5
Services	199.7	331.3	526.5
Government	167.1	270.4	404.8

Source: California Department of Finance, California Statistical Abstract, 1970.

AGRICULTURE

Agriculture in Los Angeles County has felt the impact of population growth. Between 1950 and 1969 the number of farms decreased by more than 75 percent. Harvested cropland decreased by more than 60 percent. Bearing citrus acreage decreased by more than 90 percent. Comparative agricultural statistics are shown below.

	Year 1950	Year 1969
Number of Farms	11,973	2,804
Acres in Farms	855,563	557,770
Cropland Harvested	229,047	84,319
Total Cropland	452,849	157,145
Irrigated Acreage	183,824	65,078
Bearing Citrus Acreage	46,730	4,242

Source: U. S. Census of Agriculture and Los Angeles County Agricultural Commissioner's Reports, 1950 and 1969.

County figures understate the decline of agriculture within the San Gabriel River Basin. Shifts between agricultural areas north and south of the San Gabriel Mountains are not reflected in aggregate county data. Ninety-eight percent of the county's population lives south of the San Gabriel Mountains. Local and regional plans anticipate a phase out of most agricultural operations south of the mountains by 1990.

RECREATION

The portion of the San Gabriel Mountains within the study area is within the one to two hour travel time zone from downtown Los Angeles and within a three hour travel time zone for nearly all residents in Los Angeles County. The mountains provide a scenic backdrop for over seven million people. Residents of the Los Angeles-Long Beach metropolitan complex participate in over 700 million outdoor recreation events annually within a three hour drive of their homes (3). About half occur locally, probably within urban green belts, in back yards, and along the ocean. The rest probably occur in mountain and desert areas.

Developed recreation facilities for camping and picnicking in the mountain portion of the study area are capable of servicing about 1,780 people at any one time. On an annual basis the facilities have a theoretical capacity of just over 900 thousand recreation visitor-days of 12 hour durations each. Capacity for dispersed

activities such as fishing, hunting, excursions and observation is not known but is limited only by road and trail access. Virtually all the mountain recreation occurs within the Angeles National Forest.

In 1971, the estimated recreational use was 876 thousand visitor days. Over 95 percent of this use was on the Mount Baldy Ranger District and the rest was on the small areas of the Arroyo Seco and Valyermo Ranger Districts that extend into the study area. About two-thirds of this activity was within two areas -- Crystal Lake and Mount Baldy.

A summary of recreation use by activity groupings is shown below.

Activity	Thousands of Visitor Days in 1971	Percent
Camping	359.0	41.0
Picnicking	33.9	3.9
Resort Oriented	26.7	3.1
Recreation Residents	297.0	33.9
Water Oriented	7.4	0.8
Fishing	22.3	2.5
Hunting	4.1	0.5
Winter	20.3	2.3
Excursions	82.3	9.4
Viewing, Studying, and Enjoying Open Space	23.0	2.6
Total	876.0	100.0

Source: U. S. Forest Service, Recreation Information Management (RIM)

Recreation use by area is shown in the following tabulation.

Area	Thousands of Visitor Days in 1971	Percent
Crystal Lake Composite	346.5	39.6
Mount Baldy Composite	228.2	26.0
Canyon Bottom of the San Gabriel River	63.0	7.2
Prairie Fork Composite	10.6	1.2
San Gabriel Wilderness	38.4	4.4
Dispersed use outside of the above areas	189.3	21.6
Total	876.0	100.0

Source: U. S. Forest Service, Recreation Information Management (RIM)

The value of this recreation activity was estimated to be 2.7 million dollars under criteria set by Senate Document 97 and the U.S. Forest Service (22).

WATER SUPPLY

The ground and surface waters of the San Gabriel River Basin flow through a constriction at Whittier Narrows. That portion of the basin above Whittier Narrows is referred to as the Upper San Gabriel River Basin, or upper basin, in this report.

The upper basin is a separate management unit. The "Long Beach suit" of 1959 resulted in a judgement requiring the upper basin to provide for specified annual quantities of water to pass through Whittier Narrows. The Upper San Gabriel Valley Municipal Water District has filed suit against all known pumpers in the upper basin to facilitate comprehensive groundwater management and compliance with the provisions of the "Long Beach suit" (14).

Five sources of water are available to the upper basin: imported Colorado River water, imported Northern California water, local surface water, groundwater, and reclaimed wastewater. Except during peak storm flows all local surface water is captured by storage reservoirs, enters the groundwater basin by natural percolation, or is injected into the groundwater basin by artifical recharge. Reclaimed wastewater is used for groundwater recharge and fulfillment of provisions of the "Long Beach suit". The amount of Colorado River water available will be reduced when Arizona completes her Central Arizona Project. Initial deliveries of Northern California water began in 1972.

The management plan of the Upper San Gabriel Valley Municipal Water District (MWD) calls for groundwater replenishment to the extent that withdrawals exceed average annual safe yield (13). 6 Under this plan, groundwater levels will be maintained. The suit for management control and plan implementation has not yet been settled.

A study of the allocation of upper basin water supplies to projected demands under a plan consistent with that of the Upper San Gabriel Valley MWD was conducted by the Hydraulic Laboratory of the University of California (4). The study indicated that water supplies are more than adequate through 1990. Shadow prices obtained from the linear programming analysis of the study can be used to evaluate the effect of watershed management programs on water supplies:

1. Increased water yields that feed the groundwater basin by natural percolation are worth $49 per acre foot.

2. Increased water yields that feed the groundwater basin by artificial recharge are worth $48 per acre foot.

3. Increased water yields that feed the local surface water storage and distribution system are worth $52 per acre foot.

The mountain portion of the study area produces an average annual water yield of 271,800 acre feet worth about 13.6 million dollars.

P R O B L E M S

The San Gabriel Basin, like most of the Los Angeles area, is a highly favorable place to live and work. After lagging behind Northern California in growth during the early history of the State, the Southern California Coastal Basin has increased its population at a rate seldom, if ever, equaled elsewhere. Population growth is expected to continue, although not at the high rates of the period immediately following World War II.

It is from this population growth and its attendant pressures for land and services that many of the problems in the San Gabriel Basin have evolved. The need for living and working space has led to the development of much of the available open space, including the natural flood plains. The frequency of man-caused wild fires has increased with population growth.

The San Gabriel Mountains probably rank among the most unstable in the world. Natural forces, especially periodic torrential rains on steep terrain sometimes denuded by lightning caused fires, produced great quantities of sediment prior to man's habitation of the basin. When those natural forces are aggravated by man-caused fires, heavy human use of the watersheds, and encroachment on the flood plains by man's developments,- the effects can accumulate until they become catastrophic.

The main problems to contend with in the San Gabriel Basin are synopsized here and treated in detail later in this chapter.

1. Flood Damage - Some of the floodplains in the Azusa-Glendora area are not adequately protected.

2. Sediment Yield - This is a perpetual problem caused by unstable soils, steep slopes, and severe climatic conditions, particularly sporadic heavy rains. Sediment adds to the destructiveness of flooding and makes maintenance of existing flood control facilities costly.

3. Fire - In itself fire causes physical damage to structures and has far-reaching effects upon the ecology. Its greatest influence with respect to people, however, is in increasing the damaging effects of flooding and sediment.

4. Roads - Roads are necessary if people are to use the watershed but unless great sums of money are spent in their construction, they cause large yields of sediment, particularly if they are built on the most unstable slopes.

5. Recreation - People needing recreation place tremendous pressure on the resources but the main detrimental effects are on fire starts and the need for roads.

6. Urban Development on the Flood Plain - Such development makes it necessary to construct and maintain flood protection faciliites.

7. Sand and Gravel - A shortage in raw materials will develop in the area in about 12 years. This shortage might be alleviated by utilizing sediment.

8. Beach Erosion - Large portions of the coastline in Southern California, including those in the vicinity of the San Gabriel River are experiencing serious erosion.

9. Air Pollution - This is a problem that normally follows development and is particularly bad in the Los Angeles Basin because of the air-flow barrier formed by the San Gabriel Mountains. The pollution is bad enough in places to inhibit vegetation growth.

10. Wildlife - They cause some erosion and subsequent sedimentation by trampling fragile slopes and by inhibiting growth of protective plant cover.

11. Earthquakes - The recent (1971) earthquake caused great damage and increased erosion of already unstable areas. Smaller, more frequent quakes probably have great effects upon the watershed over long time periods.

FLOOD DAMAGE

High rainfall rates in the mountains in combination with the effects of shallow soils over bedrock, steep slopes, watershed configurations that funnel and concentrate runoff quickly, and the occasional denudation of the area by fire, result in intense floods that move large volumes of sediment and debris downstream.

Damage to cultural features resulting from these flows has been considerably reduced by the installation of major flood control works over the past fifty years. The extent and comprehensiveness of these works are shown on Maps 6 and 7 following page 52. However, damages occasionally occur in areas beyond the influence of these flood control features as happened in 1969. The damages from this one event are tabulated as follows:

Type of Property	Area A		Area C		Total
	Azusa	Glendora	Main Stem	San Antonio	
	(----------------1,000 Dollars----------)				
Residential	446	661	0	125	1,232
Highways and Roads	152	747	0	780	1,679
Business	600	0	0	38	638
Utilities	17	27	0	280	324
Public	0	292	0	0	292
Channels	51	132	790	0	973
Debris Removal by C.O.E.	51	71	0	0	122
TOTAL	1,317	1,930	790	1,223	5,260

A more detailed account of flood damages in 1969 is given in Appendix B.

The only remaining mountain slopes that have uncontrolled drainages are shown as Area A on Map 4. Until recently, the flood paths from most of Area A crossed agricultural and undeveloped portions of the valley.

Some portions of Area B, however, need additional treatment to bring the level of control up to par with the rest of that area. These are the small watersheds above Azusa and Glendora that have been treated with channel stabilization structures which are not combined with debris basins or improved channels to lead their flows safely to existing flood control channels. This part of Area B now has the largest flood damage potential in the upper watershed of the San Gabriel River Basin.

Area A offers the next largest flood damage threat at the present, but damage potential there is expected to exceed that of Area B in the next twenty years if it is left untreated while urbanization continues below.

Area C on Map 4 is that part of the mountain watershed that, because of comprehensive structural measures, provides the highest level of flood damage protection to the valley below. This area contains

all the watersheds that contribute to the main stem of the San Gabriel River above the point where it flows out of the mountaina. Area C also contains San Antonio Creek. Flood damage downstream of the flood control structures has been minimal.

SEDIMENT

The problem of flooding is aggravated by the associated movement of sediment. Water moving with large amounts of sediment has greater momentum than has water without it. It congests normal flow routes and diverts storm runoff through developed lands. Sediment in this way is a direct contributor to the flood damage threat to Area A on Map 4. Sediment is particularly a problem in parts of Area B above Azusa and Glendora.

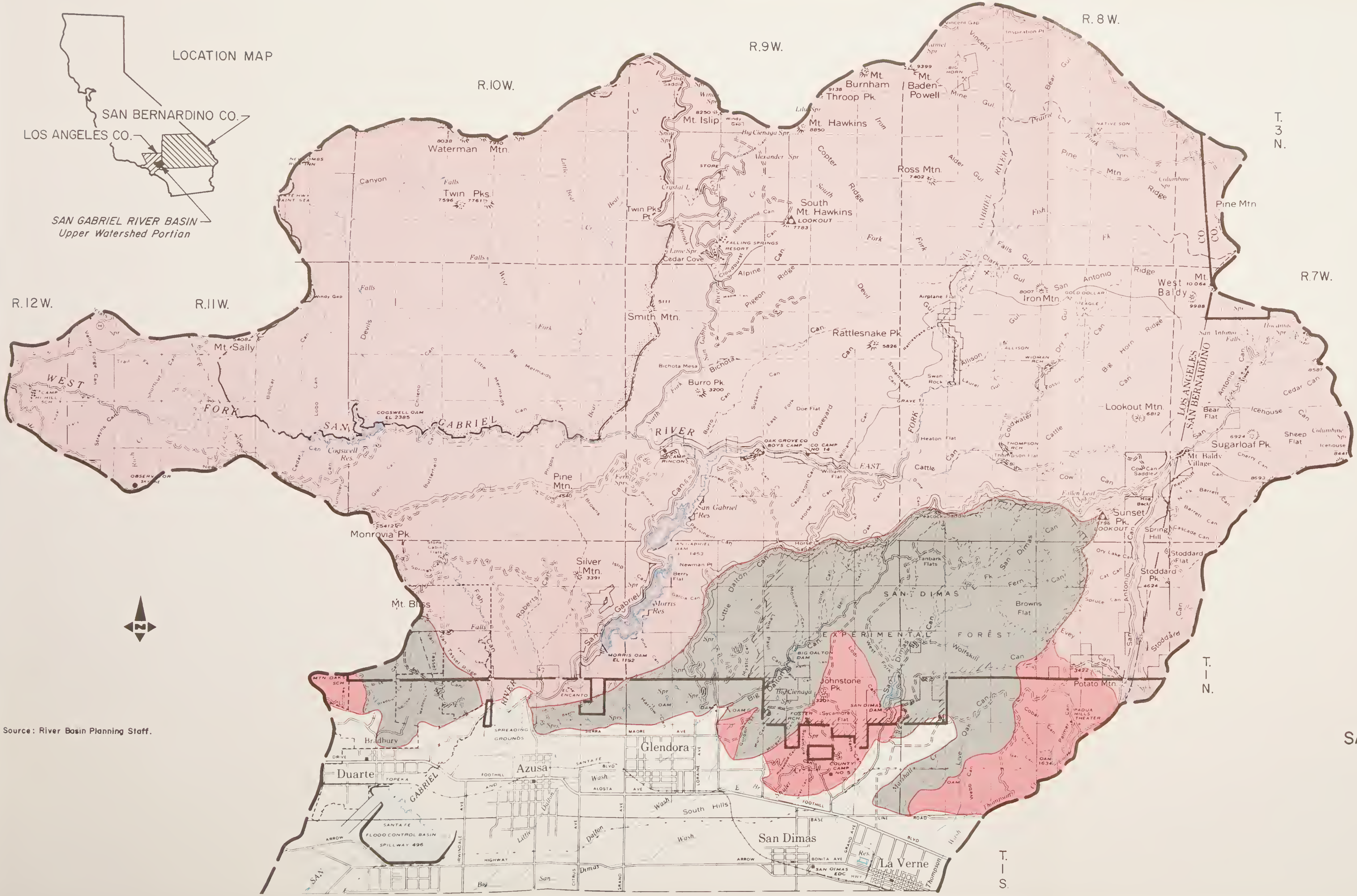
On the rest of Area B and on Area C sediment is not a direct threat to life and property because flood control dams and channels are adequate to reduce runoff peaks from storm flows and also catch the sediment. However, the very process of holding back sediment dereases the ability of structures to reduce future runoff peaks and flood damages in the valley below.

The eventual cost of removing the average annual debris inflow into existing San Gabriel Valley area reservoirs is estimated at over $1,700,000 a year, as shown in the following tabulation.

Name of Dam 1/	Uncontrolled Drainage Area (sq.mi.)	Average Annual Debris Produced (Cu.yd./sq.mi.)	Present Cleanout Cost (Cubic	DDA and Other Cost 2/ Yard)	Total Cost ($1000)
Cogswell	39.2	4162	$1.15	$0.13	209
San Gabriel	163.5	6485	1.15	0.13	1,357
Puddingstone Diversion	3.7	5453	1.50	0.13	33
San Dimas	16.2	3485	1.25	0.13	78
Live Oak	2.3	2517	1.40	0.13	9
Thompson Creek	3.5	2400	1.60	0.13	14
Total					1,700

Source: L. A. County Flood Control District

1/ No information available from Puddingston Reservoir, Santa Fe Dam, and Whittier Narrows Dam.
2/ It is assumed that right-of-way should be purchased for all debris disposal area (DDA's)



Source: River Basin Planning Staff.

PROBLEM AREAS

- Problem Area A
- Problem Area B
- Problem Area C

MAP 4
PROBLEM AREAS
SAN GABRIEL RIVER BASIN
UPPER WATERSHED PORTION
CALIFORNIA

OCTOBER 1974

SCALE 1:126,720 (0 – 3 MILES)

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1974

The 1969 storm alone deposited approximately 9,000,000 cubic yards of debris behind dams in the San Gabriel River watershed. Major reservoir cleanout operations in the San Gabriel Dam area completed by the Los Angeles County Flood Control District since 1965 have resulted in excavation of 15,000,000 cubic yards (about 25,000,000 tons) of debris.

In Area B (Map 4) present sediment yield averages 16,000 cubic yards per square mile per year, based upon debris basin cleanout records from 1956 to 1971. 3/ This average is thought to be high because during this relatively short period of record most of the watersheds above these debris basins were completely burned so they yielded exceptionally large amounts of sediment during subsequent storms. During the storm of January and February 1969, some small watersheds in Area B yielded as much as 140,000 cubic yards of sediment per square mile (12).

In Area C (Map 4) the 163.5 square miles of uncontrolled drainage above San Gabriel Dam has been monitored for sediment yield since 1939, also by cleanout records. These records indicate an average annual yield of 6485 cubic yards per square mile per year.

In Area C and in the non-emergency part of Area B the problem is one of managing sediment yields of about six thousand cubic yards annually from each square mile of watershed. The cost per cubic yard of removing sediment from behind flood control structures currently averages $2.50 in Area B and $1.10 in Area C. Costs vary because of differences in volume, accessibility of structures, and hauling distance to debris disposal areas. In both, the cost of disposing of sediments is expected to increase as 1) the private land below Area B becomes more expensive and 2) suitable sites in Area C are used and the only remaining alternative will be to deliver sediment out of the mountains.

In Area A and in the emergency part of Area B above Azusa and Glendora the problem is one of managing infrequent yields that may reach 150,000 cubic yards per square mile of watershed.

Fire is a very important factor in influencing sediment yield. Man's use of the watershed for recreation and other purposes also contributes. For example, roads cause about 140,000 cubic yards of sediment yield each year. Use of recreation areas, riding and hiking on or off forest trails, hunting and fishing, cause substantial, but

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3/ Los Angeles County Flood Control District, Debris Basin Cleanout Records, Various Years.

At about 9,000 feet elevation on the northern slopes of Pine Mountain, hydrologic failure in the mantle of shallow soils and rock outcrop resulted in severe gullying during the 1969 storm. This example of huge volumes of sediment from upper elevations was probably a result of rain on snowpack.

USDA RIVER BASIN PLANNING STAFF PHOTO

The southern exposure of San Antonio Peak (Mt. Baldy, elevation 10,064 feet) shown above, is also a high sediment contributor.

FOREST SERVICE PHOTO

Terrace deposits near the Coldbrook Guard Station.

USDA RIVER BASIN PLANNING STAFF PHOTO

Terrace materials near Bicota Mesa.

USDA RIVER BASIN PLANNING STAFF PHOTO

unestimated, amounts of sediment. Wildlife, particularly big game, cause sediment yield. Transects taken showed considerable soil loss where big game populations are heavy and where such game inhabits extremely unstable terrain.

The occurrence of fire and the influence of man so profoundly influence the watershed that much more study would be needed to arrive at what could be considered the "natural" rates of erosion and sedimentation.

FIRE

Since 1895 the average annual burn has been about 2.7 percent of the watershed area. This rate appears to be cyclic in that for two successive decades it has been much less than half a percent followed by two successive decades when it is about double the long-term average. These cycles are shown on Figure 1 which depicts the fire history of the Mount Baldy Ranger District (18).

Between 1910 and 1930 the total amount of land area burned was equivalent to about 85 percent of the watershed. Between 1930 and 1950 the total amount of land area burned was equivalent to less than four percent of the watershed. Between 1950 and 1970 the total amount of land area burned was equivalent to more than 100 percent of the watershed.

Historically (18) (over the past 75 years), acreage equivalent to the entire watershed area has been burned at least every 40 years. At a rate of 4.5% (the actual rate from 1960 to 1969) the area would be completely burned approximately every 22 years. Obviously, in those time spans, some areas would burn more than once and some would not burn at all. In general, however, these burn cycles are in part related to fuel accumulation cycles and hotter fires are produced when the number of years between burns is increased.

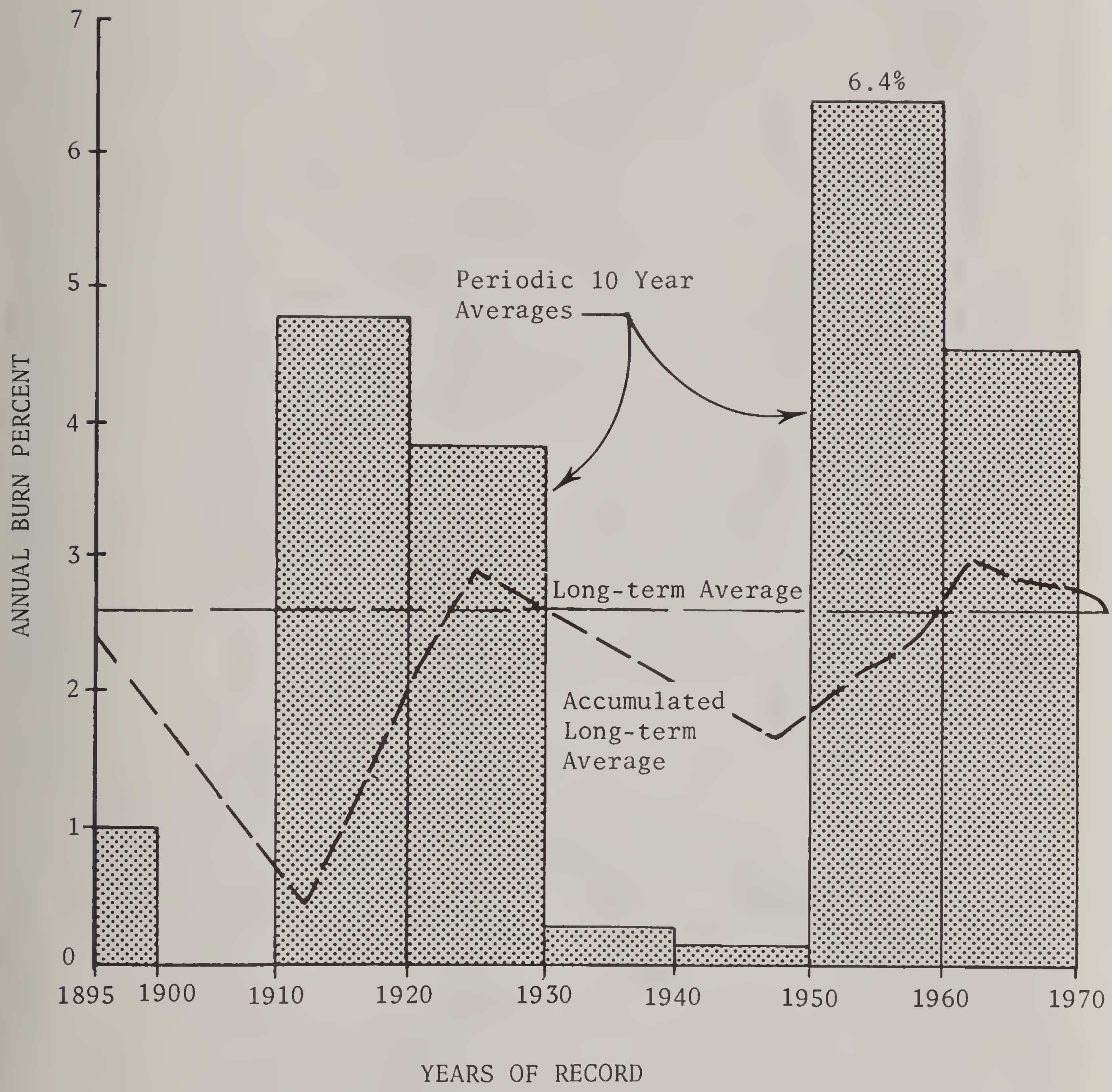
The relative contribution of various causative agents to the total number of fires started in the mountain areas of the watershed between 1960 and 1969 are listed below (16):

Cause of Fire Start	Number of Fires in 10 Years	Percent of Total
Man Caused		
Incendiary	36	22
Smoking	22	13
Recreation	19	12
Land Use		
Occupancy	19	12
Equipment	16	10
Miscellaneous	14	8
Lightening	38	23
	164	100

FIGURE 1

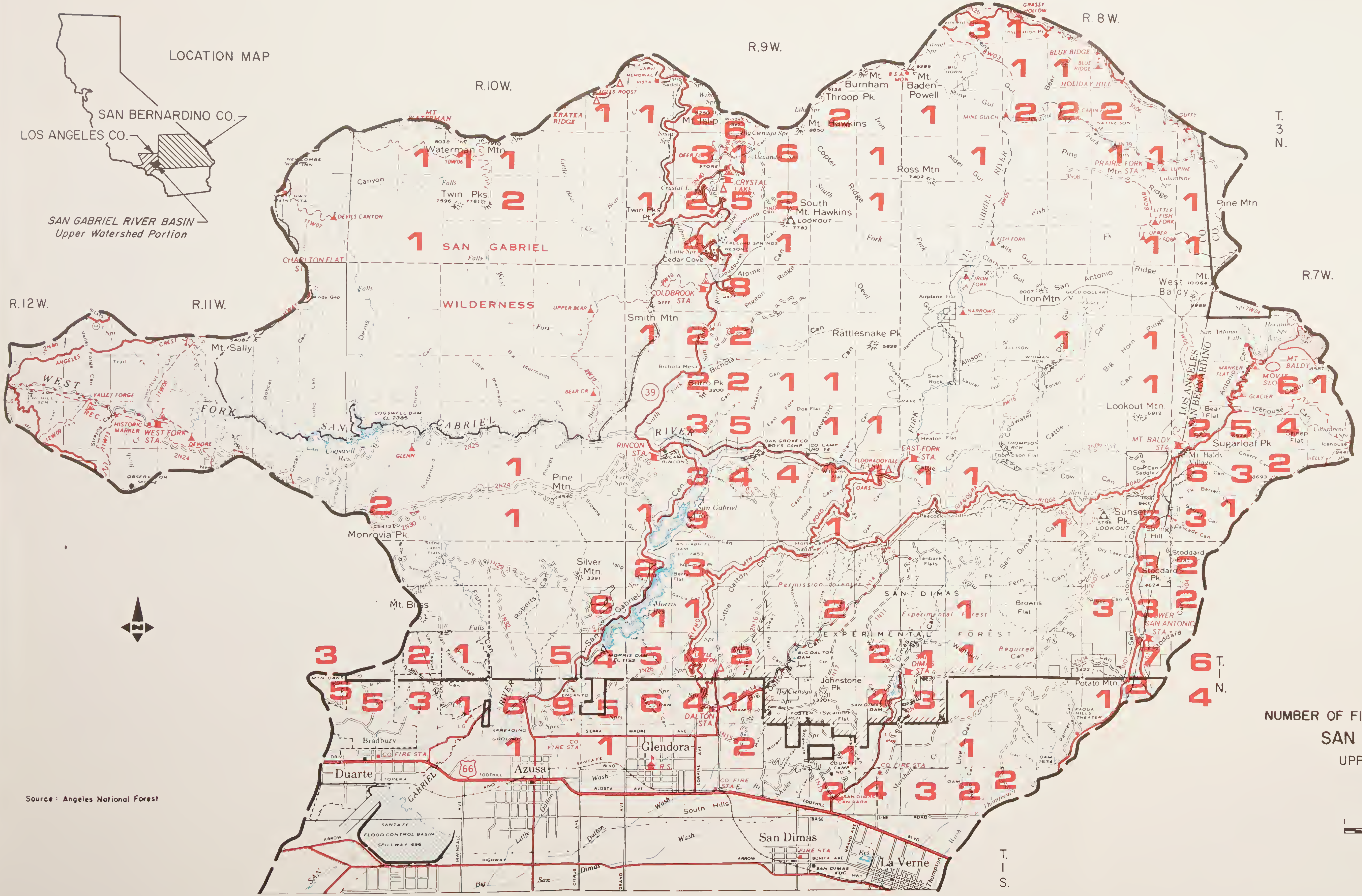
SUMMARY OF FIRE HISTORY ON MT. BALDY RANGER DISTRICT

ANGELES NATIONAL FOREST



Fire tends to convert sites from timber to chaparral, from which higher erosion rates usually result.

FOREST SERVICE PHOTO



MAP 5

NUMBER OF FIRE STARTS BY SECTION, 1960 - 1969

SAN GABRIEL RIVER BASIN

UPPER WATERSHED PORTION

CALIFORNIA

OCTOBER 1974

SCALE 1:126,720

On the Mount Baldy Ranger District, a sub-area of the upper watershed, 135 fires burned a total of 62,910 acres over the ten years. Ninety-six percent fires of these were kept small and accounted for only four percent of the acres burned while the other four percent attained sizes of more than 1,000 acres each and accounted for 96 percent of the acres burned. The relative contribution by the various causative agents to the area burned by fires larger than 1,000 acres on the Mount Baldy Ranger District during this same period is listed below:

Cause of Fire Start	Acres Burned	Percent of Total
Man Caused		
Land Use Occupancy	20,000	33
Smoking	14,737	24
Incendiary	3,210	6
Lightning	22,146	37
	60,293	100

The number of fire starts within the watershed are located by section for the years 1960 through 1969 on Map 5. They are concentrated in the frontal zone close to dense populations and along roads within the mountains where recreational opportunities are most convenient to the public. Since 1940, the number of fires started each year has more than doubled, no doubt as a result of population growth and the increased use of the watershed by people.

Currently the impact of fire is most pronounced along the frontal watersheds (Areas A and B on Map 4) where flood control structures are inadequate. The fire-storm-flood sequence and the resultant high hazard to life and valuable property makes fire protection in these small frontal watersheds critical.

ROADS

There are about 295 miles of road within the upper watershed. About 245 miles are within the national forest. Over half of the roads are under the jurisdiction of the Forest Service, about 30 miles are State highway and the balance are county roads.

To delineate and identify amounts of sediment caused by runoff from roads, a series of 0.1 mile plots were taken at two mile intervals along State Highway 39 from the lower forest boundary to the Angeles Crest Road (State 2), along Forest Road 2N24 from Rincon Station to Pine Mountain, and along various other roads within the watershed boundary. Volume estimates of erosion were made and prorated over the period of years during which the loss occurred. Sediment volumes were then calculated by estimating the proportion of eroded material that reached a channel bottom.

This road section was abandoned because major repairs became necessary too frequently. USDA RIVER BASIN PLANNING STAFF PHOTO

Road failure caused by flooding.

FOREST SERVICE PHOTO

Calculated sediment from these plots showed a wide range of yields from a high of 2.8 acre-feet per mile yearly (near the crest of Highway 39) to a low of .001 acre-feet per mile yearly (a section with no cut banks and with moderate relief). The sample average was 0.33 acre-feet per mile annually. It is estimated that these yields originate from the various portions of road prisms in the following proportions:

Road Surface	4%
Cut Banks	8%
Fill Slopes	38%
Downslope Gullies	50%

The 245 miles of roads within the national forest and the 50 miles of mountain roads adjacent to the National Forest yield about 114 acre-feet or roughly 10% of the total sediment yearly, based on a rate of 0.33 acre-feet per mile. The sample shows that sections of road that cross highly unstable terrain may produce 10 to 20 times more sediment than sections built in other terrain. The upper few miles of State 39, and Forest Service road 1N14 above Big Dalton reservoir exhibit very high rates.

Because sampling was done late in the summer after road repair and maintenance, which tends to mask and obliterate substantial losses of materials, sediment volume estimates from cut banks may be low. Also, the sample indicated that the bare skirts along paved roads seemed to be yielding as much sediment as the entire surface of the narrower unpaved roads.

RECREATION

The most apparent impact of the recreationist is his direct contribution to the fire problem. About 12 percent of the fires during the decade 1960-1969 were caused by recreationists. The activities of recreationists at present levels are believed to have only minor impact upon the hydrology of the watershed. However, by hiking and other activities man probably contributes to dry-mantle slides on steep slopes. Such factors as deer and wind have been identified as partial causes of this gravitational creep (1), and it seems logical that human activities must also contribute.

No downstream water quality problem due to upstream recreational use was identified. Sanitation facilites at both Crystal Lake and Mount Baldy are isolated from the natural drainage system and no health hazards have been reported. The rest of the watershed, except possibly for the bottom of San Gabriel Canyon, receives a low impact and practically all tributaries to the main stem contain potable waters.

A different perspective of the problem results, however, when the impact of flooding, erosion, and sedimentation upon recreational use is considered.

Although some recreational facilities have been lost or damaged by erosion and sedimentation (see above), the most important impacts are upon transportation systems. The amount of recreational use in the watershed is controlled largely by access. When access is closed, recreational use declines. The following tabulation shows the effect of closing State Highway 39.

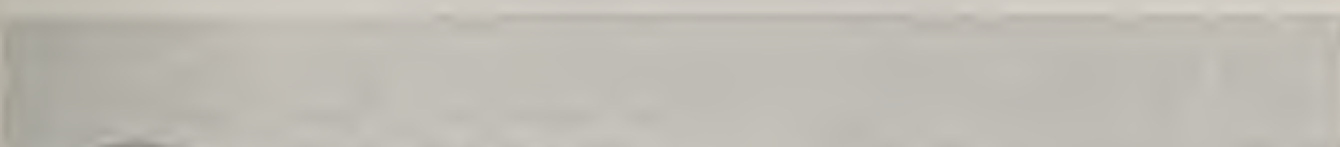
Effect of Road Conditions on Recreational Use,
Mount Baldy District

Year	Road Condition	Recreational Use in millions of Visitor Days 4/
1967	All roads open	1.2
1968	Highway 39 closed due to fire fighting activity during peak season	.98
1969	Road closure for repair of storm damage	.78
1970	Upper section of Highway 39 closed	.85
1971	Upper section of Highway 39 closed	.84

4/ USDA Forest Service, Annual Recreation Use Statistics from Recreation Information Management, (RIM).

Summer homes and campsites are located on these terrace materials in Upper San Antonio Canyon. A portion of the house shown above has been lost to erosion since this photo was taken (1972).

USDA RIVER BASIN PLANNING STAFF PHOTO



The amount of recreational use in the watershed is controlled largely by access. Note: The two slumps (encircled above) led to closure of State Highway 39 for about 3-½ years.

FOREST SERVICE PHOTO

URBAN DEVELOPMENT ON THE FLOOD PLAIN

As discussed earlier, flood water and sediment flows from some small frontal watersheds are not adequately controlled. The flood plains of these watersheds are being developed for residential and industrial use and that development is expected to continue. Current and estimated levels of residential development adjacent to the frontal watersheds is as follows:

	1970	1990
Population	26,217	77,157
Number of homes	7,387	20,971
Total housing value	$212,600,000	$645,400,000

Source: U. S. Census of Population and Housing, 1970, and development potential estimated from community general plans and zoning maps.

Except in some areas in Azusa and Glendora, land use planning and zoning has been an effective means of preventing development in areas where uncontrolled sediment and floodwater are discharged from the small frontal watersheds.

SAND AND GRAVEL INDUSTRY 5/

The sand and gravel industry has five plants in the upper valley along the San Gabriel River close to the mountains. These plants combined are selling between 15 and 17 million tons of sand and gravel annually at a value of about 20 million dollars. The amount of alluvial material extracted is estimated to be in excess of 9 million cubic yards. Available deposits and reserves are sufficient to sustain the industry, at its current rate of production, for a period of 10 to 15 years. When these deposits are depleted, continued supplies will be taken from the Cucamonga pits and the sales price to the market area now served by the local companies will be increased by about $1.25 per ton because of the extra hauling distance.

BEACH EROSION (2)

Ocean beaches are built and maintained by the natural processes of soil erosion that results in sediment being transported to the ocean by streams. Beach sand is moved onshore or offshore by the uprush

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5/ Phone interview with Mr. Mat Castellaw, Owl Rock Products, Irwindale Plant, 1362 Live Oak, Irwindale, CA.

and backwash of waves, and is also moved parallel to shore by the littoral current. This current, which is caused by ocean waves striking the shoreline at an angle, is responsible for the movement of beach sand south along the coast.

The segment of coastline from the San Gabriel River to the Santa Ana River is 12 miles of nearly continuous sandy beach with several communities built to the sand's edge. Much of this coastline is in public ownership and is used for recreation. All of this section is severely eroding. A dry cycle in the climate has contributed to the problem. It is estimated that the littoral current strips the beaches in this reach of 250,000 cubic yards of sand each year, and carries it south into the Newport ocean bottom canyon. This creates a need for periodic artificial nourishment.

Annual damages caused by this erosion are estimated at over a million dollars and are projected to reach five million dollars in the year 2020.

AIR POLLUTION

During summer months the average daily maximum oxidant pollution level near the Forest rim is about double that thought to produce adverse effects in plants and animals. A high of triple that critical level is reached at least once monthly (7).

The chlorotic needles and dying branchlets, which are caused by smog, are particularly evident in the Jeffery-Ponderosa pine stands of the upper elevation recreation areas (8). Other species appear to be somewhat less susceptible. About 20% (approximately 90 square miles) of the San Gabriel Mountain area lies within the conifer zone. The stumpage value lost because of air pollution is about $4,000 annually but this is minor compared to the loss of esthetics and recreational value.

Few sites are better than class 5 for timber growth; thus air pollution, added to an already marginal environment, tends to tip the scale towards elimination of tree growth.

WILDLIFE

Wildlife, particularly big game, cause soil erosion by dislodging soil materials as the animals traverse the steep slopes of their habitats. Much of this habitat is in the most erodible areas of the watershed, where precipitation rates are high and where there is great potential for overland flow of water. Species of all sizes, but particularly big game, also cause erosion by inhibiting the growth of plants that retard erosion.

One of the numerous slides triggered by the 1971 earthquake (see next photo). FOREST SERVICE PHOTO

EARTHQUAKES

Numerous small slides have been triggered in the watershed by recent earthquakes. The raw escarpments that result are a source of sediment because they are unstable and heal slowly. The magnitude of the most recent significant earthquake, which occurred in 1971, was 6.6 on the Richter scale and its epicenter was in the San Fernando Valley. About $2,000,000 worth of damage resulted to one dam's abutments in that area. 6/ Both the east and west forks of the San Gabriel River are within the San Gabriel fault zone, which is considered active.

The same 1971 earthquake closed the road and inflicted about $2 million of damage to the abutments of Pacoima Dam.

FOREST SERVICE PHOTO

6/ In-service report on watershed damage from earthquake of February 9, 1971 by Robert A. Reese of the US Forest Service, Angeles National Forest.

P R O G R A M S

The Resolution of the Committee on Public Works of the House of Representatives directed that this study concern itself with measures needed for flood prevention, conservation, development, utilization and disposal of water, and for flood control and allied purposes. Therefore, the existing programs discussed here are related to that objective. In the upper watershed, the area covered by this report, minimizing flooding and associated debris and sediment yield, while maintaining or enhancing the environment, were the most important considerations.

EXISTING U.S.D.A. PROGRAMS

Historically, the San Gabriel River Basin was an important agricultural area and many U.S. Department of Agriculture programs were employed in that connection. In recent years, however, urbanization has expanded to the degree that agriculture is no longer a major industry in the basin. This has led to a lessening of the need for farm-oriented USDA programs. The Forest Service, however, is charged with the management of the Angeles National Forest, which covers about 35% of the basin including the highly unstable upper watersheds that are very critical to flooding and sediment and debris yield. For these reasons, the USDA programs described are mainly National Forest oriented.

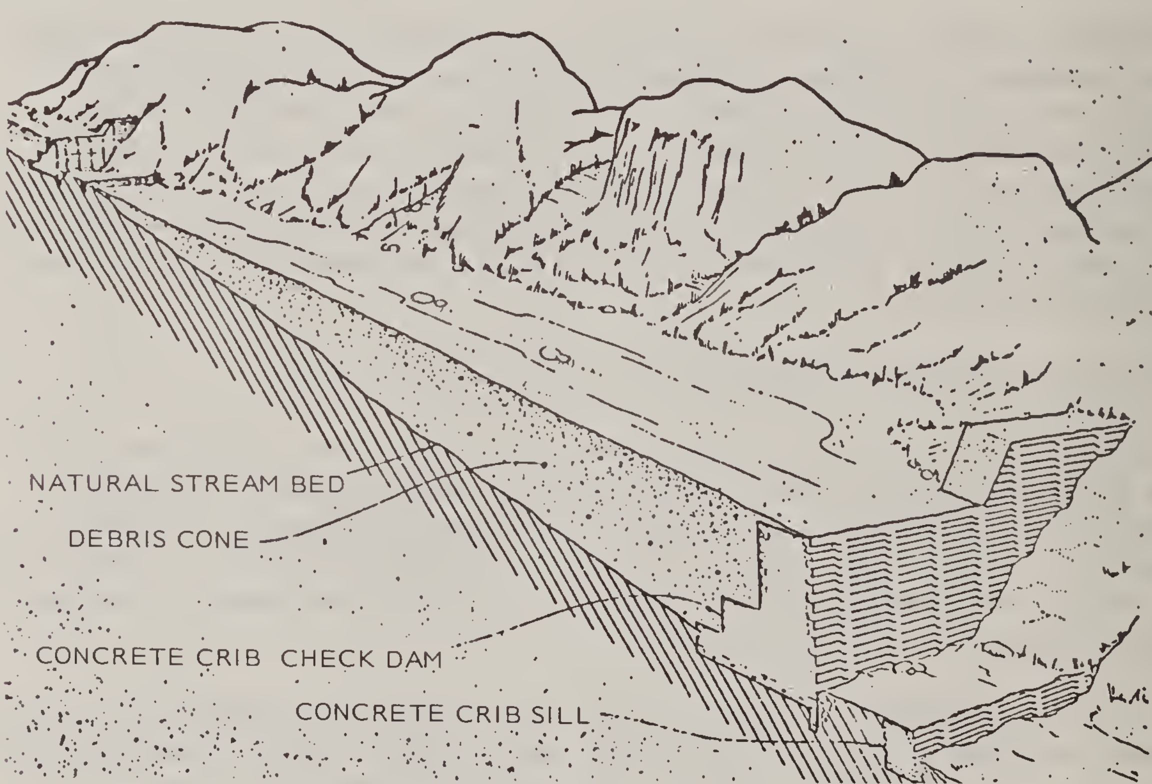
A major objective of national forest management and development has been to control or reduce erosion, particularly as it is related to man's use of the watersheds. The reasons for this policy are twofold: to maintain the productivity of the upland areas, and to prevent damage by sediment and debris downstream. There are several other values, such as esthetics, recreational quality, and water supply and quality that are more difficult to quantify but are also extremely important.

CHANNEL STABILIZATION STRUCTURES (CHECK OR CRIB DAMS)

Mountain channel stabilization structures have been installed by the Forest Service, and jointly by the Forest Service and Los Angeles County Flood Control District during the past 30 years. Formal cooperation between the Forest Service and the District is authorized under the Flood Control Act of 1936 and a 1941 Memorandum of Understanding between the two agencies.

Channel stabilization structures are check dams installed in series. The dams are designed to trap debris and reduce channel down-cutting, but allow water to pass. They reduce the frequency of cleanout of downstream flood control structures by retaining sediment upstream. To date, 76 stabilization structures have been installed in 18 canyons of the upper San Gabriel watershed.

Crib structures pictured above and in diagram below are a means of stream bank stabilization and sediment storage. COUNTY OF LOS ANGELES PHOTO



FOREST SERVICE PHOTO

FIRE

The cost of the fire control program under present policy and levels of technology, assuming a continuation of the long-term annual rate of burn, is approximately $4.40 per acre per year. About $1.80 of this pays for local staffing and manning of the existing fire control organization and the remainder is incurred for emergency fire fighting. The planned new investment in fuel breaks will add approximately 75 cents per acre per year to the local fire control organization's cost. It is expected that the fuel breaks will reduce the amount of emergency fire fighting money needed 1/ and will reduce the annual burn to under 1.4 percent for a 30 year period.

A system of fuel breaks has been in use by the Angeles National Forest for about 30 years. The first ones, sometimes called fire breaks, varied from about 10 to 20 feet in width and usually followed sharp ridgelines. These fuel breaks have gradually been lengthened and widened until, at present, widths of 200 to 300 feet are planned. The current system within the forest boundary consists of about 76 miles of fuel break with an average width of about 100 feet.

Fuel breaks of up to 300 feet widths are being cleared of vegetation by dragging a ball anchor behind tractors. Following clearing, the fuel breaks will be planted with species that produce low volumes of fuel. FOREST SERVICE PHOTO

1/ Estimates based on budgets information given over the telephone by Mount Baldy Ranger District fire control assistant.

Although the San Gabriel River Basin has one of the most intensive wildfire protection systems in the world, burned acreage has increased during the last ten-year period. The goal of eliminating all fires is obviously unattainable; but the goal of reducing the size of fires, especially those in the small frontal watersheds, seems reasonably attainable. A dependable system of fuel breaks may be the key to attaining this goal. More than the conventional fuel removal or thinning may be necessary. Wet line systems (sprinkler) are now being tried in limited areas. The need to dispose of semi-treated sewage water and of road surface runoff may provide a cheap source of water for this purpose.

The present Forest Service policy of fire management is neither one of total elimination nor total acceptance of wildfire. The objective of fire management is to specify an acceptable acreage of heavy fuels that may be allowed to burn during severe fire weather. This goal would be achieved by reducing fuel accumulations with controlled burns in light fuels during safe burning weather when heat yield is not damaging to root systems. This would smooth out the fuel cycle phenomenon (5) demonstrated in Figure 1. In theory, this system would prevent heavy fuel accumulations over large areas and high intensity fires would be less likely to burn entire drainages. Also, the small and frequent fires may be less damaging than periodic large burns.

ROADS

The Forest Service is responsible for the construction and maintenance of well over half of the 295 miles of roads within the upper watershed. Many of these roads are used to provide public access to the national forest lands. Most, however, are used for forest administration, mainly in connection with fire protection, and are not open to the public because of fire hazard.

The Forest Service road system is developed, in so far as funding permits, according to a long-range plan that balances the impacts of road construction upon the environment against the needs for public and administrative access. Once the decision to build a road is made, precautions are taken to hold detrimental effects to a minimum. Roads are located so especially unstable areas are avoided in so far as possible and are designed to fit the terrain. Precautionary measures that will help keep damage to a minimum are incorporated. Road stability is the major factor but visual impact, public safety and esthetics are also given prime consideration. For this reason, specialists, such as soil scientists, geologists, hydrologists, and landscape architects, as well as engineers, are employed.

A key factor is designing each road to fit the purpose it is to serve. A road either too elaborate or too simple can cause serious problems later. In unstable country, such as the San Gabriel mountains, the most important and expensive construction need involves adequate drainage. This often requires great quantities of pipe to carry water well away from the road; it is usually necessary to pipe the water to the nearest drainage bottom.

Providing adequate drainage involves careful planning and expensive facilities. In many areas runoff water must be piped to the channel bottom where an energy dissipator must be provided at the outlet. The pipe at left is correctly installed; the one on the right has not been completed. USDA RIVER BASIN PLANNING STAFF PHOTO

Erosion of cut and fill slopes is another important consideration. In some areas, plantings, particularly of fill slopes, has proven very successful not only for erosion control but also for beautification. Under a cooperative agreement between the Forest Service and the Los Angeles County Forester and Fire Warden, prison labor is utilized to make such plantings within the roadside zone. Most of this work is directed to fill slopes, where soil materials are deep and have the capacity to store moisture to support plant growth.

RECREATION

It is estimated that the capacity of developed family campsites, organization campsites, and picnic grounds could be doubled without adverse environmental impacts. Recent use of the watershed does not indicate a need for this maximum capacity today. Expansion plans are being developed and can be deployed in the future as use increases, but currently the program is one of operating and maintaining the existing developed capacity. (19, 21) During the past three years the recreation portion of the Mount Baldy District's $500,000 budget has averaged $93,000. This includes funds for protection and maintenance and visitor information services, and also cooperative funds contributed by the county. This is not enough money to restore old facilities that have deteriorated over the years.

EXISTING PROGRAMS OF OTHER AGENCIES

In this section, programs of agencies outside USDA are discussed. Only those programs or portions of programs that affect the upper watershed or nearby areas downstream are considered. Most of the agencies involved have jurisdiction over a much wider area. Many, perhaps most, of the programs are of a cooperative nature with several agencies coordinating their activities to serve the public in the most comprehensive and efficient manner possible under present authorities and constraints.

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT AND ARMY CORPS OF ENGINEERS PROGRAMS

Los Angeles County Flood Control District and U.S. Army Corps of Engineers have built a comprehensive system for conservation and control of flood waters in Los Angeles County. The system is composed of flood control and water storage dams and reservoirs, storm drains, flood channels, debris basins, and spreading grounds. Progress on the countywide plan is shown in Figure 2. Facilities of the San Gabriel Basin are shown on Maps 6 and 7. Of the facilities listed, only water storage dams and debris basins specifically affect the upper watershed.

Debris basins are constructed at canyon mouths to prevent sediment and debris from flowing into downstream channels and storm drains. Water is allowed to pass through the structures. Accumulated sediment and debris must be removed periodically to maintain storage capacity. Debris basins have been installed by the Corps of Engineers and the Los Angeles County Flood Control District. They can also be installed jointly by the Forest Service and the Flood Control District.

A portion of the water stored behind dams on the San Gabriel River is released at a slow rate to percolation fields. From 1966 through 1969 an average of 60,000 acre-feet yearly was absorbed in channels, reservoirs and diversions from above the Santa Fe flood control structure (28).

FIGURE 2

U.S. ARMY CORPS OF ENGINEERS
AND LOS ANGELES COUNTY FLOOD CONTROL
DISTRICT PROGRAMS IN LOS ANGELES COUNTY

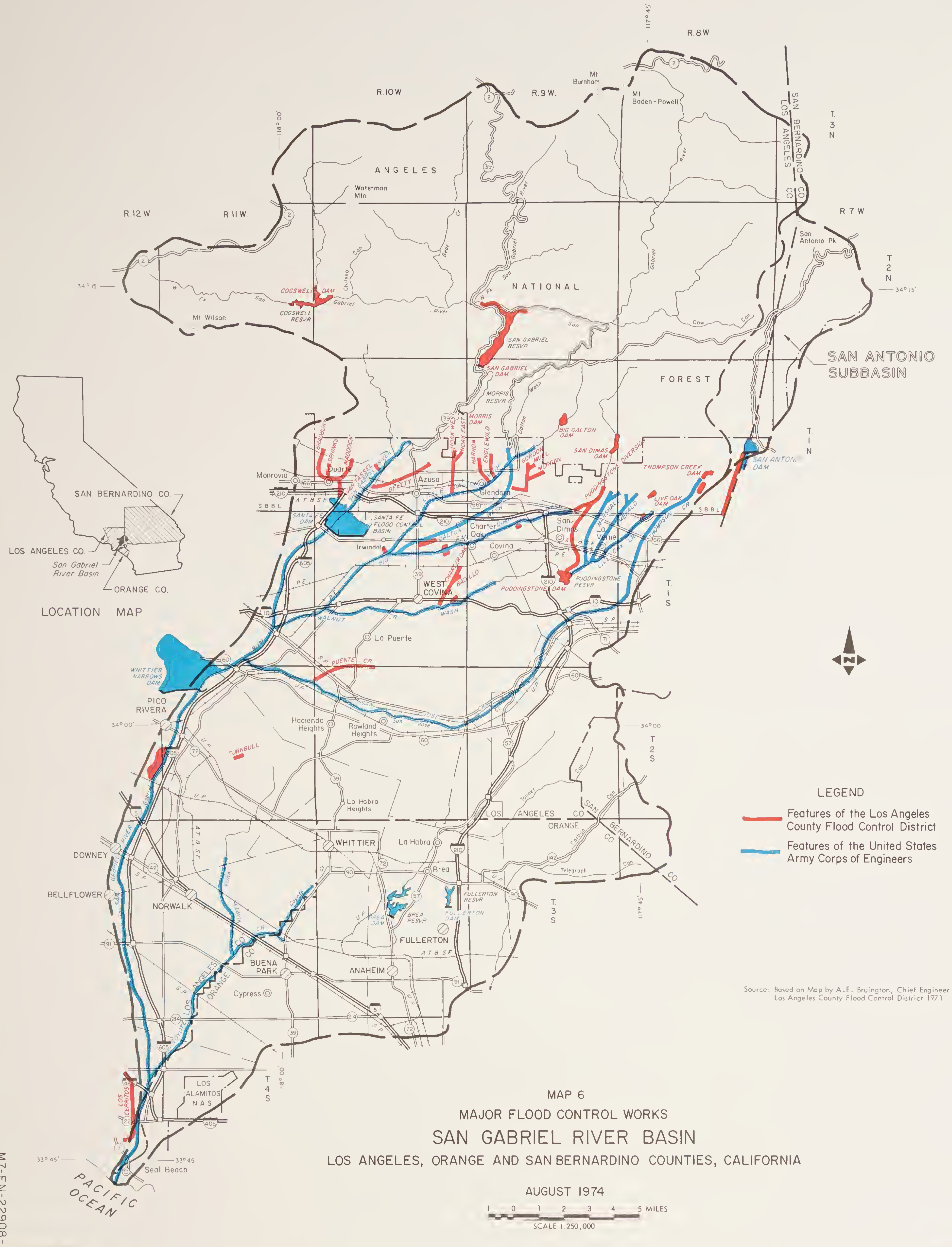
	Total Plan	Completed Through June 1971
FLOOD REGULATING DAMS		
Number	20	20
Capacity in acre-feet	237,972	237,972
PERMANENT FLOOD CHANNELS (miles)		
Los Angeles River, main channel	48	48
San Gabriel River, main channel	29	29
Rio Hondo, main channel	13	13
Ballona Creek, main channel	10	10
Laguna Dominguez System, main channel	17	17
Santa Clara River, main channel	34	0
Tributary channels	491	323
Total	642	440
DEBRIS BASINS		
Number	105	76
Capacity in cubic yards	13,164,700	8,189,500
SPREADING GROUNDS		
Number	30	27
Area in acres	2,265	2,060
STORM DRAINS		
Number	1,623	1,284
Miles	2,069	1,491
PUMPING PLANTS		
Number	36	18
SEAWATER BARRIERS		
Number	3	1

Source: Los Angeles County Flood Control District

To restrict the storm waters to particular routes that provide protection to County residents, concrete channels convey the waters along predetermined courses to spreading grounds, flood control basins, and the ocean. COUNTY OF LOS ANGELES PHOTO

Debris basins to desilt storm flows have been constructed at the mouths of many foothill canyons, the first was initiated as a result of the disastrous Montrose Flood of January 1, 1934.

COUNTY OF LOS ANGELES PHOTO



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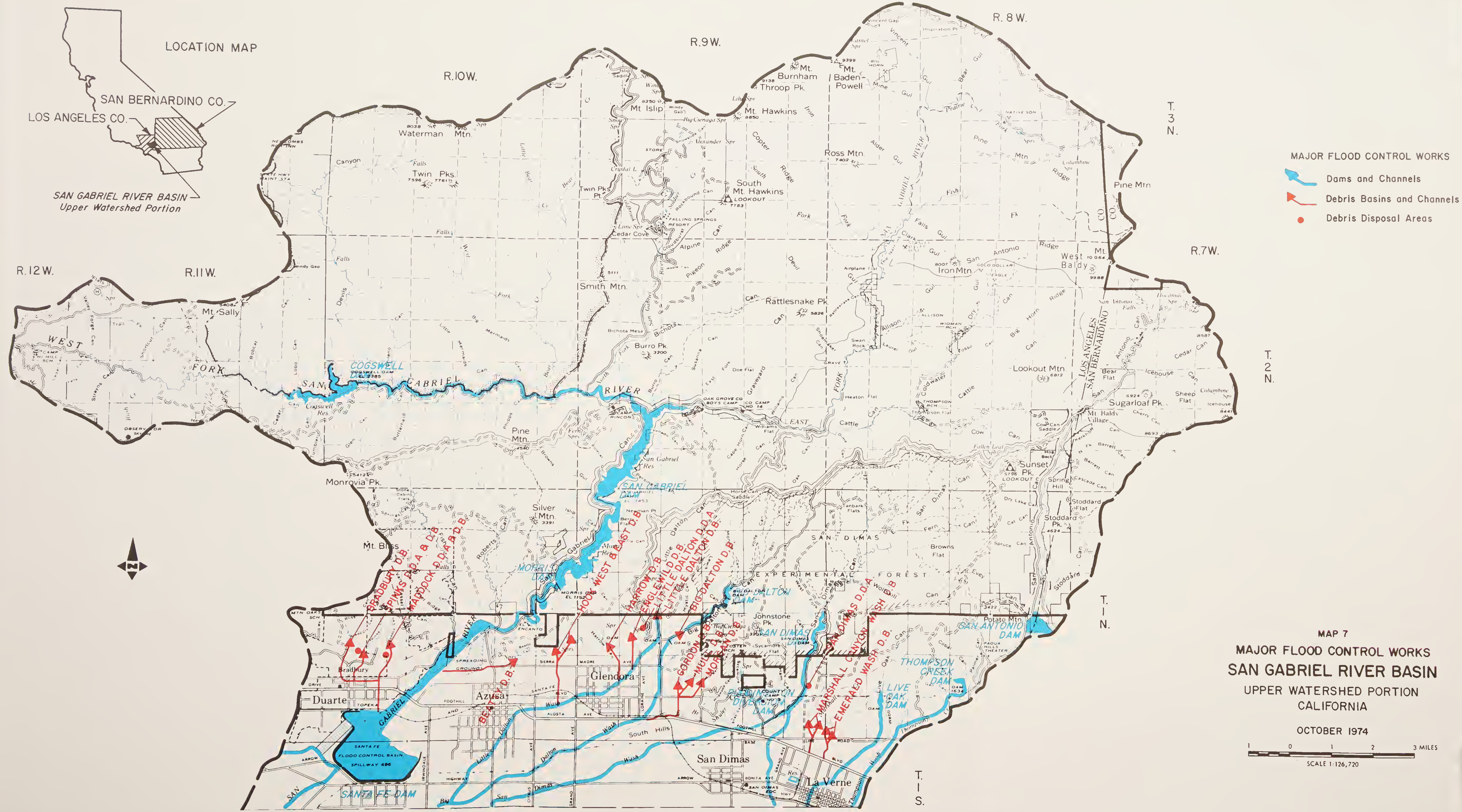

MAP 7
MAJOR FLOOD CONTROL WORKS
SAN GABRIEL RIVER BASIN
UPPER WATERSHED PORTION
CALIFORNIA

OCTOBER 1974

SCALE 1:126,720

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1974

FLOOD INSURANCE

This program was established by the National Flood Insurance Act of 1968 (enacted as part of the Housing and Urban Development Act of 1968) to make specified amounts of flood insurance, previously unavailable from private insurers, available under federal auspices. The Act requires that, to be covered by the program, State and local governments adopt and enforce land use and control measures that will avoid or reduce future flood damage in flood-prone areas. A 1969 amendment to the Act expanded the definition of flood to include mudslides, and, therefore, mudslide restrictions are also required. The program is a cooperative effort between the federal government and the private insurance industry, which is represented by the National Flood Insurers Association.

The Flood Disaster Protection Act of 1973 makes the purchase of flood insurance mandatory on any property located in identified hazard areas, provided the community is eligible and a hazard map is issued. Mandatory purchase is required on any loan by private lending institutions that are directly or indirectly regulated by an instrumentality of the Federal government. The same applies to any loans or grants made by the Federal government.

To avoid duplication of benefits, these Acts provide that federal disaster assistance will not be available to reimburse property losses to the extent that the losses are covered under flood insurance policies. These Acts also provide that no federal asistance will be available to reimburse losses that occur after July 1, 1975, to the extent that the owner could have obtained flood insurance and failed to do so.

As an interim program to provide coverage before flood hazard areas are delineated, local governments may be allowed emergency subsidized insurance for structures that are already in existence. Maximum amounts of subsidized coverage available under the emergency program are:

Single family units	$35,000 per unit
Multi-family units	100,000 per structure
Contents of units	10,000 per unit

When the local government receives its flood hazard rating map setting forth actuarial rates based upon the zone in which property is located, the regular program, in which new construction must also be insured, will replace the emergency program. Maximum amounts of subsidized coverage available under the regular program are double that of the emergency program. Actuarial rates apply for coverage above the maximum subsidized coverage.

ZONING AND SUBDIVISION CONTROL

Subdivision development is controlled and regulated under the following laws.

Subject	Reference
Laws Regulating the Division of Land	State of California, Business and Professions Code, Secton 1151.5
	Los Angeles County Ordinance No. 4478, The Subdivision Ordinance Section 158 "LAND SUBJECT TO FLOOD HAZARD, INUNDATION, OR GEOLOGICAL HAZARD."
	Section 159 "LAND SUBJECT TO OVERFLOW, PONDING OR HIGH GROUND WATER"
Laws Regarding Issuance of Building Permits	Los Angeles County Building Code, Section 308(a) "FLOOD HAZARD"
Laws Regarding Mobile Home Park Construction	California Health and Safety Code, Division 13, Part 2, Chapter 5, Article 8, Section 18378
	California Administrative Code, Title 8, Chapter 9, Article 2, Section 16259
Zoning	Zoning Ordinance, Ordinance No. 1494. (as amended), Chapter 3, Article 4, Sections 443-450
Small Dams	California State Water Code Division 3, Part 1
	Los Angeles County Ordinance No. 8692
Obstructing the Natural Flow of Storm Water	Los Angeles County Ordinance No. 1549 (as amended)
Court Decisions	Court rulings are given high priority by County Engineer in granting permits.

When a development plan meets the standards and criteria of these laws, county approval is granted. The result is that flood protection must be provided for flood hazard ares prior to development. 2/

2/ Correspondence from the Design Division of the Department of the County Engineer, Los Angeles County.

COUNTY FIRE PREVENTION AND SUPPRESSION

In cooperation with the Forest Service, the Los Angeles County Fire Department operates 11 fire stations, maintains 34 miles of firebreaks both inside and outside of the National Forest and across the frontal watershed of the San Gabriel mountains. The county fire department does all the fire hazard reduction work along the 55 miles of county road open to the public in the upper watershed and on 27 roadside plantations.

A major objective of modern road design is to lessen the need for huge cuts and fills and to provide adequate drainage to lessen the visual and hydrologic impact upon the land such as that shown above. FOREST SERVICE PHOTO

STATE AND COUNTY ROADS

State Highway 39 north of Azusa is 30 miles long and is normally maintained at an average cost of about $2,000 per mile annually. Cost for repair of damages following the 1969 flood has averaged about $42,000 per mile per year through 1972.

There are about 55 miles of county road open to the public in the upper watershed that are normally maintained at an average cost of about $1,000 per mile per year. Repair of damages following the 1969 flood has averaged about $7,000 per mile each year through 1972.

POTENTIAL PROGRAMS

The following programs are not fundable under existing U.S.D.A. authority, but are identified for consideration as sediment management alternatives.

LANDSCAPED SITES

One of the solutions to the problem of keeping the flood control structures clear of debris is to look for opportunities that call for use of land fill. Along the mountain front where most debris basins are located, the sediment might be used as fill to elevate construction sites, especially in flood hazard areas and to create areas suitable for recreation, open space or green belts. Another possibility is to acquire several of the abandoned gravel pits in the upper valley and use them for sediment disposal sites.

UTILIZATION BY SAND AND GRAVEL INDUSTRY

As mentioned in the chapter, "PROBLEMS", the sand and gravel industry has five plants in the upper valley along the San Gabriel River close to the mountains. These plants, combined, are selling between 15 and 17 million tons of sand and gravel annually at a value of about 20 million dollars. The amount of alluvial material extracted is estimated to be in excess of 9 million cubic yards. 3/

Available deposits and reserves are sufficient to sustain the industry at its current rate of production for a period of 10 to 15 years. When these deposits are depleted, continued supplies will come from the Cucamonga pits and the sales price to the market area now served by the local companies will be increased by about $1.25 per ton because of the extra hauling distance. 4/ One cubic yard of sediment in Area C produces about one ton of useable sand and gravel products with a 40 percent waste factor. It is physically possible for the sand and gravel industry to market all sediment that is of high quality.

The fact that sediment has a potential social and economic value should be fully considered in future land use and management decisions regarding areas like the main stem of the San Gabriel River.

UTILIZATION FOR BEACH REPLENISHMENT (2)

Some flood control improvements, such as those on San Juan Creek in Southern California, have increased the supply of sand to the coast by eliminating sand deposits in overflow areas and also by providing higher

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3/ Phone interview with Mr. Don Reining, Executive Secretary, Southern California Rock Products Association, PO Box 40, South Pasadena, CA.

4/ Phone interview with Mr. Mat Castellaw, OWL Rock Products, Irwindale Plant, 13632 Live Oak, Irwindale, CA.

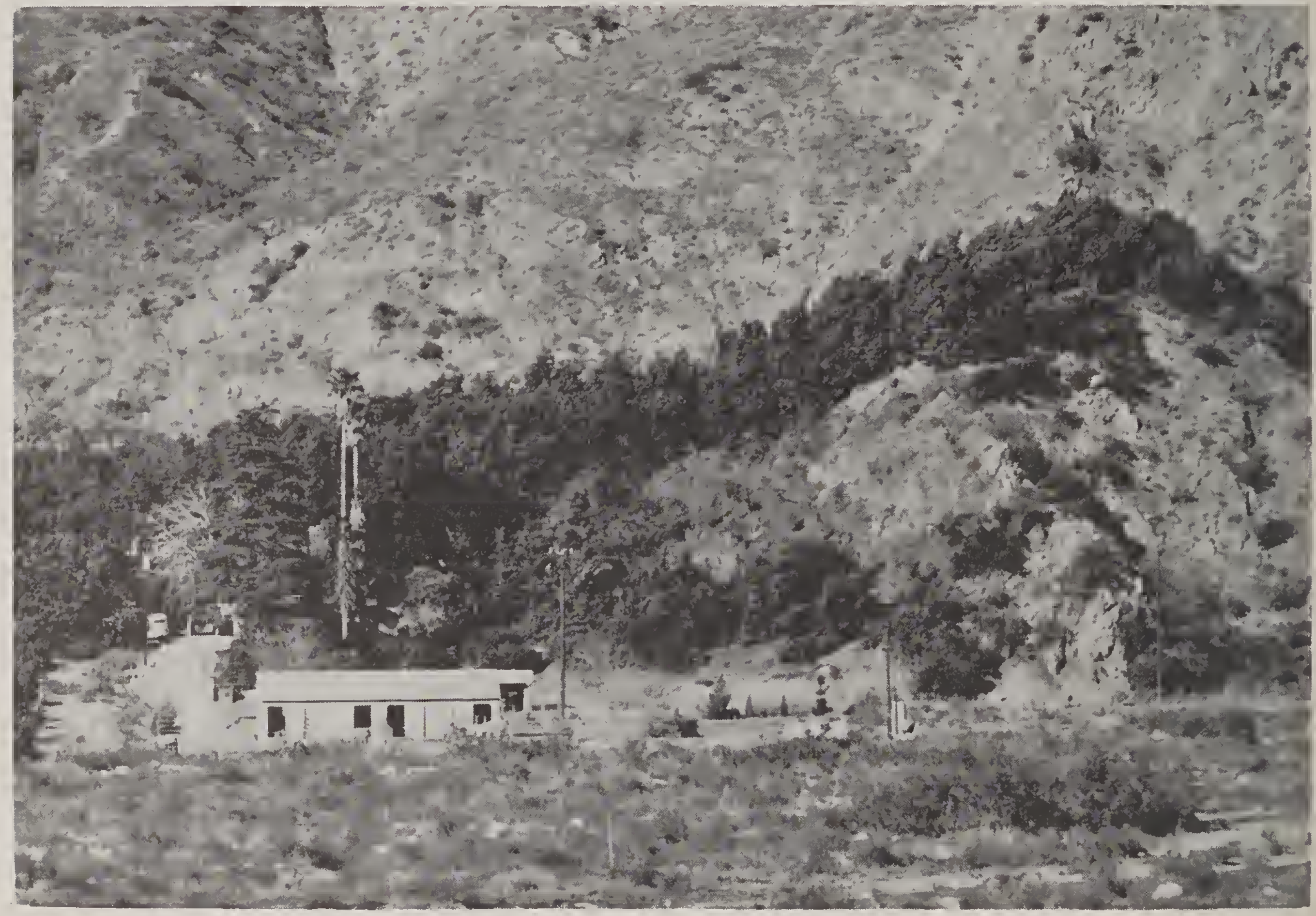
flow velocities than existed under natural conditions. The beach just south of San Juan Creek is one of the few along the southern coast that is not in danger of eroding.

Although it may not be possible to manage the San Gabriel River in a manner similar to San Juan Creek, other means of delivering sediment to the coast may be feasible such as, for example, the use of slurry pipelines.

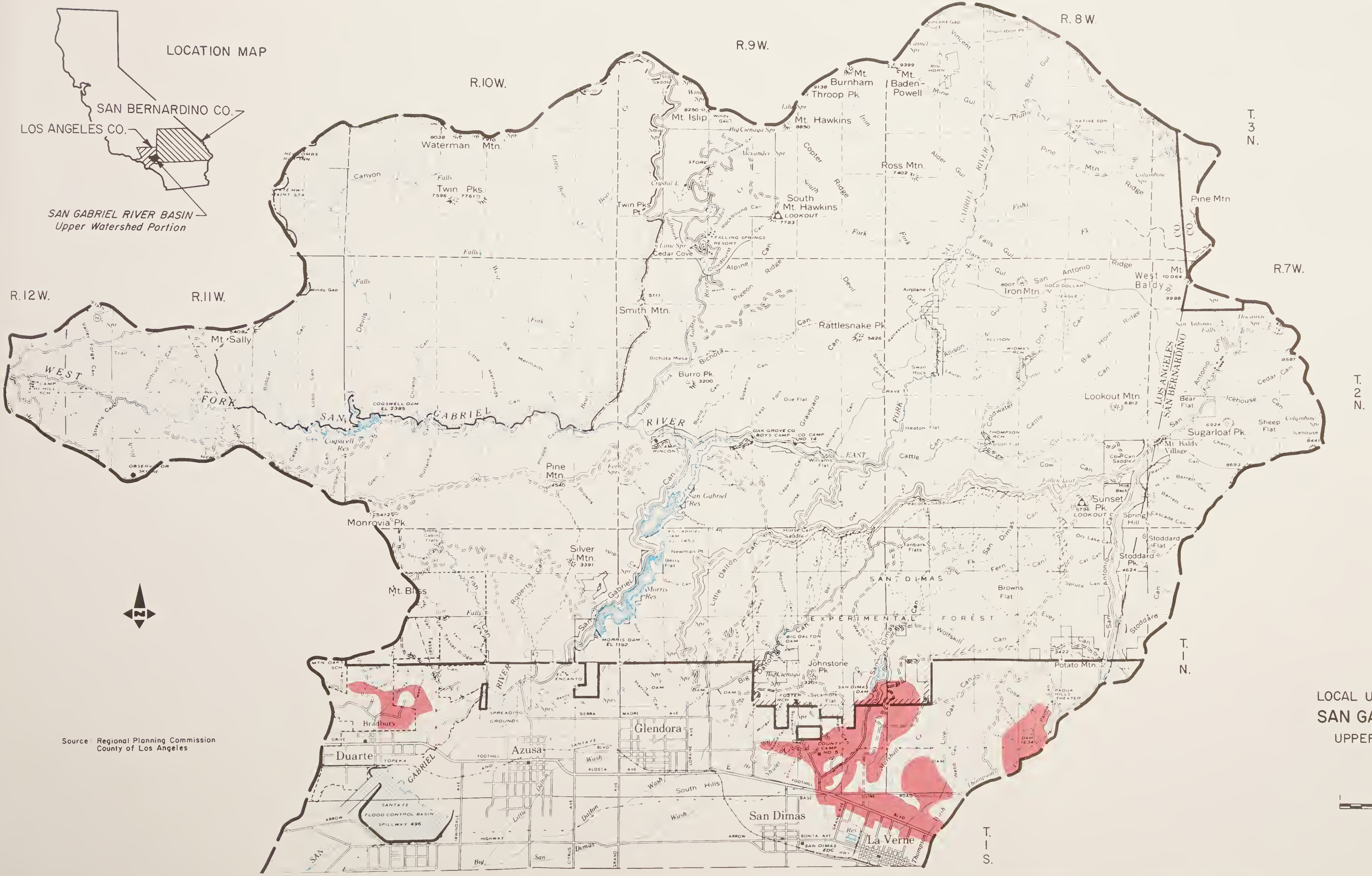
ZONING CHANGES

Land adjacent to the mountains could be zoned and purchased to create open space or green belts. Open space use could also reduce flood and fire hazards. Residential development is planned on some of the brushy slopes adjacent to the Angeles National Forest boundary (6). The location of this land is shown on Map 8.

This golf fairway serves as a greenbelt fuelbreak. FOREST SERVICE PHOTO



Orchards or vineyards can serve as fuel breaks and limit entry by the general public onto lands that have a high fire hazard. This avocado orchard is located in the mouth of San Gabriel Canyon.
USDA RIVER BASIN PLANNING STAFF PHOTO



MAP 8
LOCAL URBAN EXPANSION POLICY
SAN GABRIEL RIVER BASIN
UPPER WATERSHED PORTION
CALIFORNIA

OCTOBER 1974

1 0 1 2 3 MILES
SCALE 1:126,720

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1974

M7-N-23347-6

RECOMMENDATIONS

All recommended measures would compliment any existing or proposed downstream works accomplished or that might be considered by the Corps of Engineers. Local funding is contingent upon approval by the Los Angeles County Board of Supervisors.

Analyses have been detailed enough that the cost data can be used as a basis for appropriation of funds. An interest rate of 5-7/8 percent was used throughout the analyses.

1. It is recommended that fire management measures be installed and that special funding be allocated to do so. Such funding will assure that the regular fire programs of the responsible agencies will be supplemented to the extent needed to achieve the best possible fire protection.

2. It is recommended that nine small debris basins and connecting storm drains be installed. Although their benefit-to-cost ratio is less that one, a flood of the magnitude of the one that occurred in 1969 could result in loss of life, inconvenience, and disruption of normal activities in addition to property losses.

3. It is recommended that land stabilization measures be installed. These measures will reduce sediment, result in more dependable access to the public, and reduce repair costs on man-made structures.

4. It is recommended that $200,000 be allocated for cooperative work with the Los Angeles County Flood Control District on a matching fund basis for coordination of planning, legislative and hydrologic data collection activities.

5. It is recommended that $350,000 be allocated for a sediment management study by the Los Angeles Flood Control District. The average annual deposition of sediment represents a cost burden of approximately $1.7 million. The study is needed to design a feasible and appropriate long-term sediment management system. This report is to be supplemented with new program recommendations when the study is completed.

Tables 1 through 4 summarize costs, benefits, and other information on these recommended measures.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

San Gabriel River Basin, California - (Upper watershed portion)

Installation Cost Item	Unit	Number			Estimated Costs (Thousands of Dollars)						
		Federal Land	Non-Federal Land	Total	Federal Land			Non-Federal Land			Total Cost
					Federal	Non-Federal	Total	Federal	Non-Federal	Total	
FIRE MANAGEMENT											
Fire Stations	Each	3		3	240		240				240
Helicopter	Each		1	1					500	500	500
Water Cisterns	Each	10		10	46		46				46
Fuel Breaks	Mile	40		40	2,320		2,320				2,320
Tanker Facility	Each	1		1	178		178				178
Supervision					280		280		—	—	280
TOTAL FIRE MANAGEMENT					3,064		3,064		500	500	3,564
DEBRIS BASINS											
Storm Drains	1,000 ft.		13.8	13.8					1,610	1,610	1,610
Debris Basins	Each		9	9				1,897		1,897	1,897
Right-of-way	Acres		33	33					165	165	165
Engineering	Each		9	9				371	371	742	742
Administration	Each		9	9				185	185	370	370
TOTAL DEBRIS BASINS								2,453	2,331	4,784	4,784
LAND STABILIZATION											
Roads											
Forest Service	Mile	158		158	226		226				226
County Road Dept.	Mile	37	2	39	360	330	690		30	30	720
State Div. Hwy.	Mile	5	—	5	1,500	—	1,500		—	—	1,500
Sub-total		200	2	202	2,086	330	2,416		30	30	2,446
Other Land	Acres	1,750		1,750	460	—	460	115	—	115	575
TOTAL LAND STABILIZATION					2,546	330	2,876	115	30	145	3,021
COOPERATIVE PLANNING								200	200	400	400
SEDIMENT MANAGEMENT STUDY					160		160	190		190	350
TOTAL PROJECT					5,770	330	6,100	2,958	3,061	6,019	12,119

TABLE 2 - ANNUAL COST 1/

San Gabriel River Basin, California - (Upper Watershed Portion)
(Thousands of Dollars)

Evaluation Unit	Amortization of Installation Cost Federal	Non-Federal	Total	Operation & Maintenance Cost Federal	Non-Federal	Total	Total Cost
Fire Management	170	31	201	161	184	345	546
Debris Basins	127	121	248		27	27	275
Land Stabilization							
Roads	113	20	133	negligible 2/	negligible 2/	negligible 2/	133
Other Land	27		27	negligible	negligible	negligible	27
Cooperative Planning	11	10	21				21
Sediment Management Study	20		20				20
TOTAL PROJECT	440	210	650	161	211	372	1,022

1/ Based on 5-7/8 percent interest (see Tables 5 and 6 in Appendix A for the effect of a 6-7/8 percent interest rate).

2/ Negligible only with respect to the measures. Current road maintenance will continue.

TABLE 3 - COMPARISON OF PROJECT BENEFITS AND COSTS 1/

San Gabriel River Basin, California - (Upper watershed portion)
(Thousands of Dollars)

Evaluation Unit	Average Annual Benefits	Average Annual Costs	Benefit Cost Ratio
Fire Management	652	546	1.19 : 1.0
Debris Basins	175	275	0.64 : 1.0
Land Stabilization			
Roads	215	133	1.62 : 1.0
Other Land	33	27	1.18 : 1.0
Cooperative Planning	2/	21	2/
Sediment Management	63	20	3.15 : 1.0
TOTAL PROJECT	1,139	1,022	1.11 : 1.0

1/ Based on 5-7/8 percent interest (see Tables 5 and 6 in Appendix A for the effect of a 6-7/8 percent interest rate.)

2/ Intangible benefits.

TABLE 4 - SCHEDULED ALLOCATION OF APPROPRIATED FUNDS

San Gabriel River Basin, California - (Upper watershed portion)
(Thousands of Dollars)

Project Measures	Fiscal Year 1	2	3	4	5	6	7	8	9	10	Total Project by Measure
Fire Management	884	678	788	454	564		196				3,564
Debris Basins	55	373	998	1,046	1,262	1,050					4,784
Land Stabilization											
Roads	380	379	479	445	445	186	66	66			2,446
Other Land	15	60	62	63	62	63	62	63	63	62	575
Cooperative Planning	80	80	80	80	80						400
Sediment Management Study	70	70	70	96	44						350
TOTAL PROJECT BY YEAR	1,484	1,640	2,477	2,184	2,457	1,299	324	129	63	62	12,119

FIRE MANAGEMENT

The program elements described are supplemental to the regular fire management program, which is funded from normal appropriations to the various agencies responsible. The total measure involves investments of $3,564,500 in new fuel breaks, water cisterns, the modernization of facilities at three fire stations, and the purchase of a 10-place helicopter by the county fire department, and calls for operating costs of $398,000 annually above previous planning levels. Some of the additional operating costs are for fire prevention, mainly information and education efforts along the front country adjacent to Areas A and B on Map 4, and in schools and civic groups in foothill communities. The rest of the operating costs are for two aircraft--a small fixed wing airplane rented by the Forest Service to patrol the front country during days of very high fire danger and a 10-place helicopter, operated by Los Angeles County, with new superintendent and foreman positions. The goals of this measure are to meet the objectives of the national fire plan sooner than would be the case if flood money were not made available, to reduce the ratio of fire starts to population, and to shift the number of fires out of Class C size (10 to 100 acres) and above, into Class A and B sizes (under 10 acres). The expected result is a smaller expenditure of emergency firefighting funds and a reduction in the annual burned area to less than 1.4 percent of the watershed during the next 30 years.

According to this plan, fire prevention efforts in the foothills and in San Gabriel Canyon will be strengthened by reinforcing and realigning existing forces. In addition, a fixed wing aircraft patrol will be used at Fire Manning Plan 7 (very high fire danger) to monitor public use and enforce closure restrictions. The patrol will consist of a contract airplane and pilot with a Forest Service observer. This will involve about 15 days per year with approximately four hours of flight time per day. Costs will run about $140 per day or about $2100 per year.

One yearlong fire prevention technician will be added to provide 7-day coverage in the front country. Total costs for this measure are estimated at $10,600 per year. Also, to abet the fire prevention program, a prevention unit will be employed to dispense fire information and education to schools, civic groups, etc., in the foothill communities at a cost of approximately $13,000 per year.

Initial attack will be augmented by a large helicopter to be stationed at Tanbark Flats. It will be manned by a nine-man crew, with two additional yearlong people to support the helicopter. Cost for helicopter and crew is estimated at about $53,000, with $24,000 for support personnel.

Los Angeles County, in cooperation with the Forest Service, will furnish a Bell 205A helicopter at a cost of about $500,000, plus annual costs of $200,000 for operation.

Los Angeles County, in cooperation with the Forest Service, will furnish a Bell 205A helicopter at a cost of about $500,000, plus annual costs of $200,000 for operation.

Other U.S.D.A. (Forest Service) additions to the fire protection efforts include two water cisterns at an estimated installation cost of $18,500 during the first year, and the addition of eight more during the next four years at a cost of $7000 per year.

A program of heavy maintenance, modernization and improvement is planned for the next five years at the fire stations at Rincon, San Gabriel and Tanbark Flats at the estimated cost of $40,000 in the first year, $100,000 in the third year, and $100,000 in the fifth year. There is also a need for $7,000 in additional maintenance for all facilities.

Plans are to purchase a Model 51 Tanker and construct garage and storage facilities at Crystal Lake in the seventh year of the accelerated program at a cost of $178,000. Annual operation and maintenance for that complex is estimated to be more than $74,000 per year over present costs.

The bulk of the accelerated fire protection program, however, will be vested in the fuel management program. New fuel breaks are planned to be installed according to the following schedule and cost:

Year 1	5.8 miles @ $50,000 per mile	estimated cost	$290,000
Year 2	10.5 miles @ $58,000 per mile	estimated cost	$609,000
Year 3	10.5 miles @ $58,000 per mile	estimated cost	$609,000
Year 4	7.0 miles @ $58,000 per mile	estimated cost	$406,000
Year 5	7.0 miles @ $58,000 per mile	estimated cost	$406,000
		Total estimated cost	$2,320,000

Increased maintenance is planned on existing fuel and fire breaks at an estimated annual cost of $20,000.

To adequately supervise the installation of the measures, it is estimated that costs equal to about 10% of the installation costs will be needed, approximately $280,000.

The following is a summary of economic, environmental and social effects:

ECONOMIC EFFECTS

BENEFICIAL

Annual Equivalent Value of Sediment Reduction	$652,000
Reduction in Average Annual Expenditure of Emergency Firefighting Funds (not estimated)	$ ---
TOTAL	$652,000

ADVERSE

Average Annual Cost	$546,000

NET EFFECTS

Annual	$106,000

ENVIRONMENTAL AND SOCIAL EFFECTS

Reduces frequency and size of large fires that burn in heavy fuels during hot, dry and windy weather conditions.

Reduces the area burned to less than 1.4 percent of the upper watershed each year during a 30-year period following installation of fire management measures.

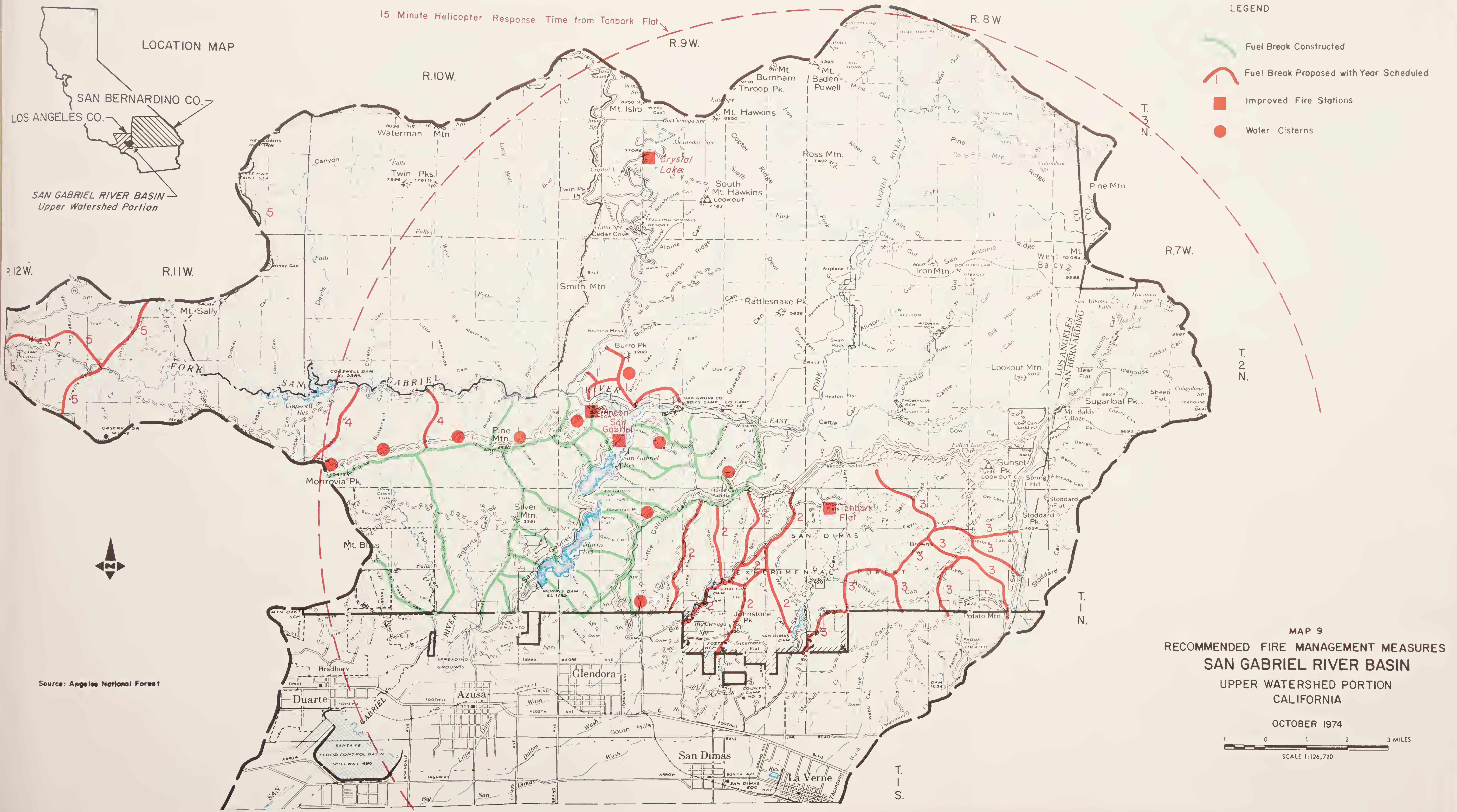
Reduces sediment inflow to streams and reservoirs in the upper watershed during the 30-year period when the burned area is held to less than 1.4 percent annually. Average annual reduction in sediment resulting from management measures during this period will be about 513,500 cubic yards.

Increases the amount of climax wildlife habitat during effective period of measure.

Improves visual appeal of upper watershed.

Reduces sediment removal activity.

Reduces air pollution (smoke from wild fires).



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M7-N-23347-7

Increases sedimentation from land cleared for fuel breaks by 1000 cubic yards annually.

Changes visual appeal because of fuel breaks and helicopter landing pads.

Reduces possibility of fire damage to life and property.

SMALL DEBRIS BASINS AND CONNECTING STORM DRAINS

This measure, as planned, calls for $4,784,000 for the installation of nine small debris basins and storm drains that would connect the debris basins with existing storm drains previously constructed by the Los Angeles County Flood Control District. Seven of these structures are intended for the relatively small frontal canyons above Azusa and Glendora where the L.A. County Flood Control District and the Forest Service installed check dam systems as emergency flood control measures following the fire and flood sequence that occurred an 1969. The purpose of this measure is to upgrade or replace those existing improvements to provide flood protection for downstream urban areas. Project concepts include adequate debris basins with improved storm drains, constructed to Los Angeles Flood Control District standards.

The other two structures are planned for Buena Vista Canyon and Canyon No. 51b above Duarte. These canyons are untreated and flood and debris flows could inundate about 25 homes constructed on the natural canyon bottoms and then spread into an urban area directly below the mouths of the canyons. If existing storm drains plug with debris during flooding, the downstream urban area would be subject to extensive damage. Installation cost estimates were derived from average unit construction indices.

Information from the recent $252,000,000 storm drain bond issue was used as a basis for initial estimates. Land right-of-way acquisition costs were estimated at $5,000 to $10,000 per acre depending on the project location. Yearly cleanout estimates and associated debris disposal area (DDA) costs were based on the estimated average annual debris inflow. Cleanout costs were estimated at $3.00 per cubic yard and DDA costs were estimated at $0.20 per cubic yard. Maintenance of basin and storm drain channel structures was estimated at 10 percent of cleanout cost and engineering costs at 20 percent of the installation costs. Administration and construction inspection costs were estimated to be 10 percent of installation costs. The total operation and maintenance cost of this measure will be about $34,000 per year.

Damages to property were estimated on the basis of flood loss data from the 1969 storm. Flood area maps were examined, runoff was estimated, and a relationship was developed for each canyon. To calculate average annual damages, a runoff frequency based on historical rainfall was assigned to the flood flows. The names and identification numbers of the nine canyons to be treated by this measure are listed below:

Watershed No. Name	Area Sq.Mi.	Storm Drain 1000'	Basin Capacity 1000 CY	No. of Homes Affected	Installation Cost $1000
37 Glenco	0.108	2.3	24.0	9	958.1
39 Harding	0.106	2.6	24.0	15	685.1
39a Pennsylvania	0.067	1.8	13.5	25	491.8
39b Rainbow	0.092	1.3	23.0	11	504.9
39c Girlscout	0.030	0	7.0	11	162.9
40b Hicrest	0.050	2.0	12.0	5	496.1
41b Hilltop West	0.039	0	13.0	33	243.4
51 Buena Vista	0.139	3.3	27.8	14	862.0
51b (No name)	0.075	0.5	17.5	25	379.6
Total	0.705	13.8	161.8	148	4,783.9

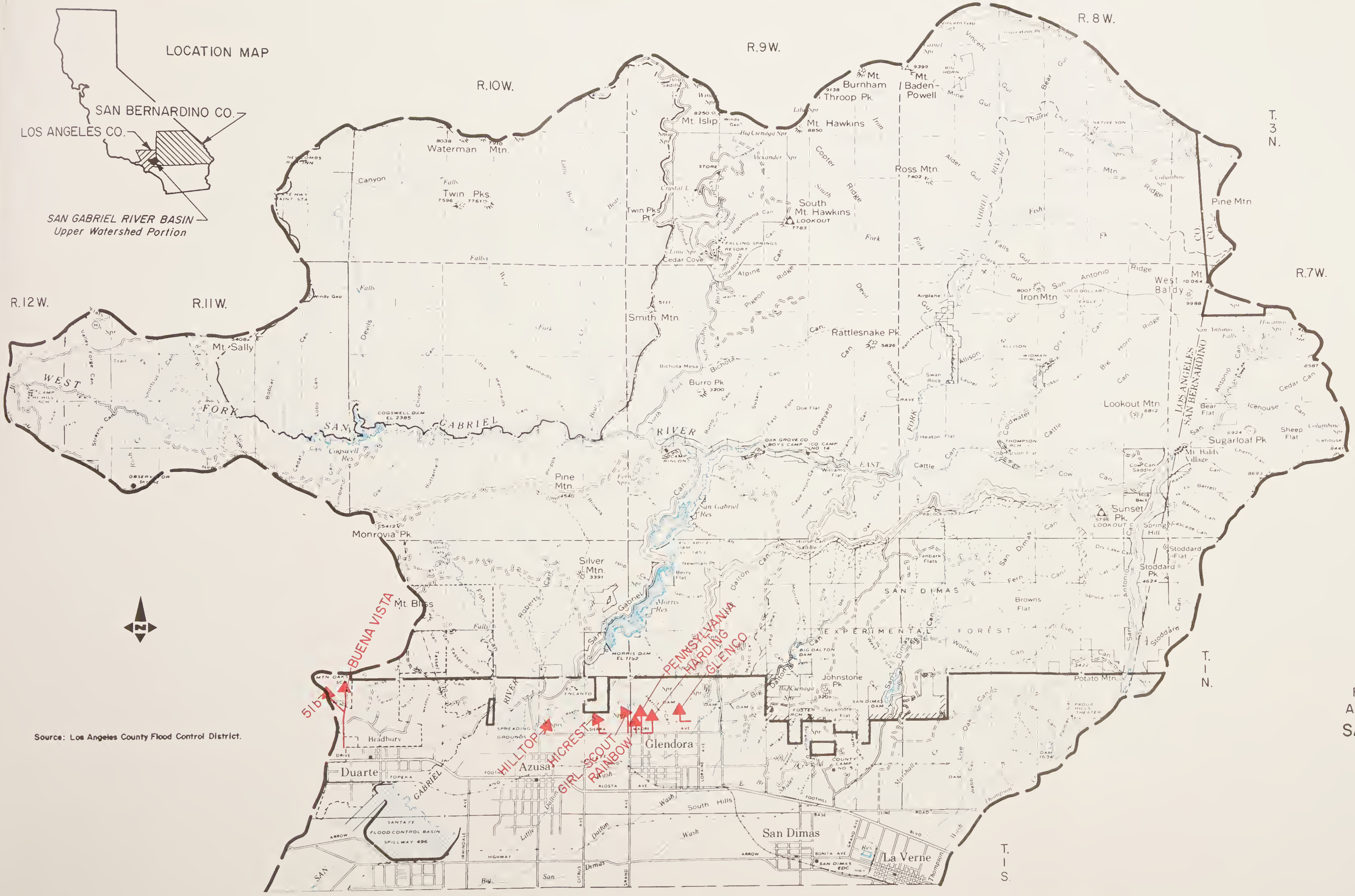
Installation Cost Item	Amount in $1000
Storm Drains	1,610.0
Debris Basins	1,897.3
Right-of-way	165.0
Project Engineering	742.1
Project Administration	369.5
Total	4,783.9

The following is a summary of the economic, environmental and social effects:

ECONOMIC EFFECTS

BENEFICIAL

Most probable average annual reduction in flood and debris flow damage to residential property, not including damage reduction benefits to existing and proposed storm drains themselves.	$176,000



LEGEND

Proposed Debris Basin and Connecting Storm Drain

MAP 10

RECOMMENDED DEBRIS BASINS AND CONNECTING STORM DRAINS

SAN GABRIEL RIVER BASIN

UPPER WATERSHED PORTION

CALIFORNIA

OCTOBER 1974

1 0 1 2 3 MILES

SCALE 1:126,720

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ADVERSE

Average annual equivalent cost	$275,000

NET EFFECTS

Annual	-$ 99,000

ENVIRONMENTAL AND SOCIAL EFFECTS

Sediment from 0.705 square miles of watershed above the structures is prevented from flowing into urban areas because of a critical event catchment capacity of 161,800 cubic yards.

Sediment removal activities are necessary to maintain catchment capacity. The average annual removal requirement is 9,740 cubic yards from the nine basins. The excavation, trucking, and disposal actions produce dust and noise and create a traffic hazard on narrow residential streets.

Provides protection of developed urban property from damage and prevention of loss of life from flood and debris. Will eliminate damage like that which occurred from floods of 1938 and 1969. This kind of protection is provided to at least 148 homes. Negative individual social values such as discomfort, inconvenience, insecurity, and trauma are reduced

Protection of existing and proposed storm drains.

Visual impact of the structures.

LAND STABILIZATION

Each of three agencies has jurisdiction over portions of the road system in the upper watershed. The total estimated cost of land stabilization measures associated with these roads is $2,446,000.

Where the State has jurisdiction, investments would be mostly for the construction of high dikes, retaining walls, or embankments, extending downdrains and terminating them with energy dissipaters, and establishing vegetation on road fills on the newly completed section of State Highway No. 39 (a Forest Highway) above Crystal Lake.

Where the County has jurisdiction, investments would be for masonry walls, improved drainage, and fill stabilization through planting.

Where the Forest Service has jurisdiction, investments would be mostly in retaining walls of various materials and design including bin walls, in re-vegetation, in extending or placing new overside drains, in berm construction, and in the use of rip-rap. The road surface would be fitted with dip crossings (small fords) and paved ingutters on insloped roads. The cut-slope treatment would include retaining walls, landing mat check dams, and intercepting drains with downspouts.

The State and County measures were formulated in cooperation with the respective agencies. The Forest Service program results from a road survey done specifically for this study. This survey, consisting of 90 plots, represented a six percent sampling of all Forest Service roads in the upper watershed. It resulted in the location of 187 individually evaluated treatments. The program is an expansion of this survey to 158 miles of road. The evaluation period is 50 years for all agencies.

Other land, not directly associated with roads, is also in need of stabilization. These areas originally began eroding critically from the following causes:

1. wildfire
2. earthquakes
3. heavy rainstorms and floods
4. research activities

This measure is formulated on the tentative identification of 1750 acres of such kinds of land. The $575,000 cost of this measure includes the completion of a detailed inventory of critically eroding areas and a treatment analysis of each prior to expenditures on the ground to assure cost effectiveness.

Stabilization is to be achieved mainly from the establishment of brush and tree vegetation of species that have been tried and proven in the area. Data from the San Dimas Experimental Forest indicate that the amount of reduction in sediment can be enough to more than cover the cost of this measure, not to mention aesthetic, wildlife, and some water quality benefits.

The following is a summary of economic, environmental, and social effects:

ECONOMIC EFFECTS

BENEFICIAL

Annual equivalent value of sediment reduction	$121,000
Annual equivalent value of reduction in road maintenance and repair	$127,000
Total	$248,000

ADVERSE

Average annual cost	$160,000

NET EFFECTS

Annual	$ 88,000

ENVIRONMENTAL AND SOCIAL EFFECTS

Reduces sedimentation of streams and reservoirs by an average amount of about 126,000 cubic yards per year.

Reduces road-surface sediment removal of over 400 cubic yards annually; and the dust, aire pollution, and road congestion associated with excavation, trucking, and dumping of debris and sediment.

Stabilizes road fills and prevents about 400 probable road failures over a 20 year period.

Improves vegetation on more than 77 acres of planted fill slopes and on 1750 acres of other land.

Wildlife ranging from deer to song birds will benefit from planting of species favoring their nutrition and cover.

Blends natural materials in masonry walls with surrounding geology.

Produces visual impact due to contrast of culvert extensions and use of non-natural raw materials in construction of retaining walls.

Helps maintian access to recreation areas by reducing frequency of road closures.

Improves road safety.

Reduces demands on local government financing and property tax to maintain road.

Reduces employment of excavation contractors in debris basin and reservoir cleanout.

COOPERATIVE PLANNING

Authority for land use planning and regulation in the mountain and foothill areas except on National Forest lands is vested in the various cities and counties. Effective guidance and coordination of their planning and zoning activities will be necessary to prevent the creation of future flood hazards by unwise development of flood plains.

Activities to be carried out under this matched fund measure include the following:

1. Analyzing the general plans of each local agency along the foothills, with particular attention to the land use, conservation, open space, safety, recreation, and public services and facilities elements to identify planning proposals which are illogical from the standpoint of erosion and flood hazard, and to identify opportunities for satisfying general plan requirements in ways which are compatible with or which reduce the flood and erosion hazard.

2. Working with and coordinating the activities of local agencies toward making changes in the general plan as identified above, and in implementing the revised plans through zoning, subdivision, and building control.

3. Providing technical data on flood hazard evaluation in support of legislation which would provide tax incentives to property owners for the development of green belts of various kinds between the chaparral fuels and populated areas.

4. Organizing and implementing a system for gathering and maintaining data on erosion and flood producing hydrologic phenomena, including rainfall, runoff, fire, fire-burned soils, sediment production, and the effects of erosion control measures.

5. Organizing an emergency preparedness flood protection program by which fast action can be taken to rally materials and manpower for installing needed structures immediately after a fire and before the subsequent storm season has a chance to inflict possible damages. Emergency work in 1969 was accomplished after damages occurred.

This measure is anticipated to require five years to complete, at which time a report will be published detailing the accomplishments achieved.

The following is a summary of economic, environmental, and social effects:

ECONOMIC EFFECTS

BENEFICIAL

Not estimated	expected to be substantial

ADVERSE

Average annual cost	$21,000

NET EFFECT

Annual	expected to be substantial

ENVIRONMENTAL AND SOCIAL EFFECTS

Increase communication among local authorities.

Reduce flood and erosion damage.

Increase public safety.

Conserve open space.

Enhance outdoor recreation opportunities.

New legislative proposals to provide tax incentives for the development of green belts.

Establish a common public data bank for gathering existing information on all phases of natural processes and for monitoring man's influence upon them.

SEDIMENT MANAGEMENT STUDY

A sediment management study is needed to find methods of reducing sediment management costs associated with maintaing existing flood control measures. The average annual deposition of sediment represents a cost burden of approximately $1.7 million. The study is needed to design a feasible and appropriate long-term sediment mangement system. This report should be supplemented with new program recommendations when the study is completed. Possible alternatives to be investigated would include:

1. Slurry pipelines or conveyor belt systems for sediment transport.

2. Construction of debris barriers above mainstem reservoirs.

3. Construction of channel stabilization structures.

4. Use of sediment for beach replenishment or for supplying the sand and gravel industry.

A five year study, involving three full-time scientists, would cost a total of $350,000. It is estimated that the benefits would be at least $85,000 annually, based upon the assumption that the study would result in programs that would reduce sediment management costs a minimum of 5%. Any further reduction would, of course, increase the value of the benefits. Suggested references for guiding the study are:

1. Clark, W.B. and Fuller, W.P. "Quarry to Mill by Pipeline" _California Geology._ pp 207-13, illus., September 1973.

2. Los Angeles County Flood Control District, _Study of Feasibility of San Gabriel Canyon Debris Dams_, (File No. 53.41) August 24, 1962.

3. Los Angeles County Flood Control District, _Study of Removing Debris through Rock and Gravel Operations at San Gabriel Reservoir_, (includes various supplemental reports), 1959.

4. USDA, Forest Service, Angeles National Forest, _Los Angeles River Flood Prevention Project Review Report_, (includes various supplemental reports), May 1974.

TABLE 5 - ANNUAL COST 1/

San Gabriel River Basin, California - (Upper Watershed Portion)
(Thousands of Dollars)

Evaluation Unit	Amortization of Installation Cost Federal	Non-Federal	Total	Operation & Maintenance Cost Federal	Non-Federal	Total	Total Cost
Fire Management	191	36	227	165	191	356	583
Debris Basins	142	134	276		27	27	303
Land Stabilization							
Roads	126	22	148	negligible 2/	negligible 2/	negligible 2/	148
Other Land	30		30	negligible	negligible	negligible	30
Cooperative Planning	12	11	23				23
Sediment Management Study	22		22				22
TOTAL PROJECT	523	203	726	165	218	383	1,109

1/ Based on 6-7/8 percent interest (see Tables 2 and 3 in body of report for the effect of a 5-7/8 percent interest rate).
2/ Negligible only with respect to the measures. Current road maintenance will continue.

TABLE 6 - COMPARISON OF PROJECT BENEFITS AND COSTS 1/

San Gabriel River Basin, California - Upper watershed portion)
(Thousands of Dollars)

Evaluation Unit	Average Annual Benefits	Average Annual Costs	Benefit Cost Ratio
Fire Management	661	583	1.13 : 1.0
Debris Basins	169	303	0.56 : 1.0
Land Stabilization			
Roads	211	148	1.42 : 1.0
Other Land	30	30	0.00 : 1.0
Cooperative Planning	2/	23	2/
Oediment Management Study	60	22	2.73 : 1.0
TOTAL PROJECT	1,131	1,109	1.02 : 1.0

1/ Based on 6-7/8 percent interest (see Tables 2 and 3 in body of report for the effect of a 5-7/8 percent interest rate.)

2/ Intangible benefits.

A P P E N D I X B

GLENDORA AREA STREAMS

Dollar Losses:

January and February 1969 Storm Damages.

Type of Property	Physical Damages	Business Loss	Total
Residential	$ 566,000	$ 95,000	$ 661,000
Highways & Roads	687,000	60,000	747,000
Utilities	24,000	3,000	27,000
Public	272,000	20,000	292,000
Channels	132,000	0	132,000
Debris Removal by COE 1/	71,000	0	71,000
Totals	$1,752,000	$173,000	$1,930,000

1/ Debris removal from Rainbow and Glencoe Debris Basins and from a camp in Girl Scout Canyon by COE under P.L. 875. Does not include FCD debris removal. Of the $71,000, $15,000 was for the removal of debris from the camp. *

Damage:

Summary - Debris basins for Glencoe, Rainbow, Harrow (Easley), Englewild, Hook East and West, and Girl Scout Canyons overtopped. Severe damage to water, sewer, power and telephone lines. Five homes destroyed, 200 homes damaged. Autos destroyed or damaged and downstream channels filled with debris.

Deaths:

None.

* COE and FCD stand for Corps of Engineers and Flood Control District.

Damage:

Englewild & Hyman Canyons - Rectangular concrete channel in canyon on upstream side of Sierra Madre Avenue clogged at the point where the channel transitions to a 96 inch pipe. Debris flows damaged 15 homes and yards before reaching Little Dalton Wash.

Deaths:

None.

Restoration Work:

Englewild Canyon - 1 check dam; capacity 25,283 cu. yds. Tributary area 0.398 sq. mi. Cost: $51,722

Hyman Canyon - 1 check dam; Tributary area 0.44 sq. mi.; Capacity - 11,909 cu. yds.; Cost: $20,958 (Note: Hyman has one additional dam built in 1962.)

Damage:

Glencoe Canyon - Produced most devastating and extensive damages. Produced debris flow 200' wide, buried 1 home, severe damage to 15 other homes. At Palm Drive combined flows from Glencoe and Harrow Canyons moved south along Live Oak and Cullen Avenues damaging 27 more homes and yards. Debris deposition damage to streets severe. Major street damage on Glencoe Drive, Live Oak Avenue, Cullen Avenue, and Palm Drive.

Deaths:

None.

Restoration Work:

Glencoe Canyon - 5 check dams; 0.108 sq. mi.; capacity 58,015 cu. yds. and 880 feet of lined channel. Total cost - $288,522. (Glencoe Hts. road utilized as a channel to carry desilted flows from dams).
Harrow Canyon - 5 check dams; 0.223 sq. mi.; capacity 45,897 cu. yds. Cost - $159,247.

Damage:

Harding, Pennsylvania, Rainbow and Girl Scout Canyons. Debris from Harding and Pennsylvania Canyons deposited on grounds of Harding Military Academy and on the yards of 30 homes along Glendora Avenue with some damage to the homes. Flows continued down Glendora Avenue, across Sierra Madre Avenue and through one block of Leadora Street.

Mudflows from Rainbow and Girl Scout Canyons moved down Rainbow Drive damaging 54 homes, destroying 2 homes. Damage most severe on west side of Rainbow Drive.

Deaths:

None.

Restoration Work:

Harding Canyon - 1 check dam; Tributary area 0.106 sq. mi.; 7.020 cu. yds. capacity; Cost - $30,568.

Pennsylvania - 1 check dam; Tributary area 0.067 sq. mi.; 38,469 cu. yds. capacity; Cost - $49,043.

Rainbow Canyon - 4 check dams; Tributary area 0.092 sq. mi.; 43,881 cu. yds. capacity; 165 feet of channel; Total Cost - $163,712.

Girl Scout Canyon - 3 check dams; Tributary area 0.055 sq. mi.; Capacity 14,111 cu. yds.; 1,071 feet of channel; Total Cost - $102,861.

1/ No Debris Basin
2/ Temporary Debris Basin
3/ FCD Debris Basin

Damage:

Hook East 1/; Hook West 2/; and Barn Canyons- Hook East debris basin overtopped causing extensive damage to Azusa Pacific College, destruction and complete blockage of downstream channel, destruction of 1 home and severe damage of 26 homes - all downstream of Sierra Madre Ave. Combined flows from Hook East and West caused extensive damage to buildings of St. Lucy's Priory and destroyed 1 large old residence on south side of Sierra Madre Avenue. The conduit carrying the combined flows downstream from Sierra Madre Avenue was completely plugged. Barn Canyon is tributary to and contributed to the damages attributed to Hook West.

Deaths:

None.

Restoration Work:

Hook East - 1 check dam; Tributary area 0.143 sq. mi.; Capacity 9,431 cu. yds.; Cost - $50,465.

Hook West - 3 check dams; Tributary area 0.125 sq. mi.; capacity 19,583 cu. yds.; Cost $109,765.

Barn Canyon - 1 check dam; Tributary area 0.52 sq. mi.; Capacity 66,381 cu. yds.; Cost - $56,594.

Summary of Expenditures for Restoration Works:

Construction of Check Dams and Channels	
New Debris Basins (Hook West, Gordon, Mull)	$1,083,457

1/ Had permanent FCD Debris Basins
2/ New FCD Debris Basin - 1970

Summary of
Glendora Area Streams

Canyon Name	Area Sq. Mi. 1/	Debris Basin Status	Year Basin Constructed	Number of Check Dams	Major 1969 Flood Damage 4/
Barn	0.052	7/	---	1	Yes
Hook West	0.17	Perm. FCD	1969-70	3	Yes
Hook East	0.18	Perm. FCD 5/	1967-68	1	Yes
Girl Scout	0.055	8/	---	3 3/	Yes
Rainbow	0.092	7/	---	4 3/	Yes
Pennsylvania	0.067	Private Temp.	---	1	Yes
Harding	0.106	7/	---	1	Yes
Harrow	0.43	Perm FCD 5/	1957-58	5	Yes
Glencoe	0.108	Dam M-1A is a debris basin	1969	5 3/	Yes
Hyman	0.044	7/	---	2 6/	Yes
Englewild	0.40	Perm. FCD 5/	1960-61	1	Yes

Summary of
Glendora Area Streams (Continued)

Canyon Name	Area Sq. Mi. 1/	Debris Basin Status	Year Basin Constructed	Number of Check Dams	Major 1969 Flood Damage 4/
Little Dalton	3.31	Perm. FCD	1958-59	0	No
Big Dalton	2.62 2/	Perm. FCD	1958-59	0	No
Gordon	0.18	Perm. FCD	1972-73	0	No
Mull	0.15	Perm. FCD	1972-73	0	No

1/ Above first permanent control structure.
2/ An additional 4.49 sq. mi. area above Big Dalton Debris Basin is controlled by Big Dalton Reservoir.
3/ Plus channel lining.
4/ As reported by COE report, Appendix D.
5/ Basins overtopped by 1969 flood flows.
6/ M-1 constructed in 1962 under contract from FCD.
7/ One of the existing check dams can be used as a debris basin.
8/ Check Dam W-1 can be cleaned out, M-1 and E-1 cannot.

AZUSA AREA STREAMS

Dollar Losses:

January and February 1969 Storm Damages.

Type of Property	Physical Damages	Business Loss	Total
Residential	$ 366,000	$ 80,000	$ 446,000
Highways & Roads	122,000	30,000	152,000
Business	500,000	100,000	600,000
Utilities	15,000	2,000	17,000
Channels	51,000	0	51,000
Debris Removal by COE 1/	51,000	0	51,000
	$1,105,000	$212,000	$1,317,000

1/ Debris removal from Beatty and Hilltop Debris Basins by COE under PL 875. Does not include FCD debris removal costs.

Damage:

Beatty and Hilltop Canyons - Most damage due to flows from Beatty and Hilltop Canyons. Beatty Canyon mudflows severely damaged a large commercial nursery; Hilltop Canyon flows damaged a residential subdivision at the canyon mouth when a storm drain plugged. The flow moved overland along the streets to Sierra Madre and Dalton Avenues where flows from Beatty and Hilltop combined and spread westward to Azusa Avenue and south to 10th Street. About 150 homes were damaged along Azusa, Alameda and Dalton Avenues where flows filled streets and yards to a depth of 1 foot. Two homes on [illegible] Drive and 1 home on Circle Dell Drive were almost demolished. [illegible] miles of streets were damaged by deposition and erosion.

Deaths:

None.

Restoration Work:

Hilltop Canyon - 3 check dams; Tributary area 0.059 sq. mi.; Capacity - 35,799 cu. yds.; Cost $91,022.

Beatty Canyon - 3 check dams; Tributary area 0.209 sq. mi.; Capacity - 35,991 cu. yds.; Cost - $117,289.

Damage:

Nursery, Lost Mine, and Hicrest Canyons - No damage due to flows from these canyons was included in the COE Report, Appendix D.

Deaths:

None.

Restoration Work:

Nursery Canyon 1/ - 3 check dams; Tributary area 0.067 sq. mi.; Capacity 73,069 cu. yds.; Cost - $118,391.

Lost Mine Canyon 2/ - 1 check dam; Tributary area 0.003 sq. mi.; Capacity - 1,479 cu. yds.; 302 feet of channel work; Total Cost - $58,408

Hicrest Canyon 3/ - 2 check dams; Tributary area 0.050 sq. mi.; Capacity 12,022 cu. yds.; 603 feet of channel work; Total Cost - $109,267 (Note - Hicrest private road improved to carry desilted flows.)

Summary of Expenditures for Restoration Work:

Construction of Check Dams and Channels	$ 494,377

1/ Flows resulted in damage to the nursery.
2/ Flows damaged 2 homes.
3/ Flows inundated 1 older home.

Summary of
Azusa Area Streams

Canyon Name	Area Sq. Mi. 1/	Debris Basin Status	Year Basin Constructed	Number of Check Dams	Major 1969 Flood Damage 2/
Hilltop	0.059	Dam M-1 is a debris basin	1970-71	3	Yes
Beatty	0.27	Perm. FCD	1969-70	3	Yes
Nursery	0.067	4/	---	3	No
Lost Mine	0.003	None	---	1 3/	No
Hicrest	0.050	Dam M-1 is a debris basin	1970	2 3/	No

1/ Above first permanent control structure.
2/ As reported by COE Report, Appendix D.
3/ Plus channel lining.
4/ One of the existing check dams can be used as a debris basin.

Dollar Loss:

January and February 1969 Storm Damages (Below Morris Reservoir).

Type of Property	Physical Damages	Business Loss	Total
Total (all channel)	$790,000	0	$790,000

Damage:

A stabilizer structure (built by the Atchison, Topeka, and Santa Fe Railroad Co. in about 1900 to stabilize the channel near the Railroad bridge) in the San Gabriel River approach channel to Santa Fe Reservoir was damaged by flood flows.

Deaths:

1 man killed by debris flow after refusing to heed warnings of a Sheriff's Deputy to evacuate the area.

1 eleven year old boy swept to his death while playing in a storm drain in Hacienda Heights, a community located 16 miles east of L. A. Civic Center.

Restoration Work:

A new stabilizer structure was constructed by the COE with $790,000 of P.L. 99 funds.

SAN ANTONIO CREEK

Dollar Losses:

January and February Storm Damages.

Type of Property	Physical Damages	Business Loss	Total
Residential	$ 100,000	$ 25,000	$ 125,000
Business	30,000	8,000	38,000
Highways & Roads	700,000	80,000	780,000
Utilities	250,000	30,000	280,000
Total	$1,080,000	$143,000	$1,223,000

Damages:

Where San Antonio Creek flows through Mt. Baldy Village, the banks were overtopped, a 70' span bridge severely damaged; a lodge with guest cabins and 15 homes also severely damaged and 4 homes destroyed. Four miles of the old Mt. Baldy road either washed out or severely damaged. Water, power and telephone lines either destroyed or damaged. Mt. Baldy Village residents were evacuated.

Deaths:

None.

Restoration Measures:

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